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Flood Boundary and Floodway Map Index
Flood Boundary and Floodway Map

PUBLISHED SEPARATELY:

Flood Insurance Rate Map Index
Flood Insurance Rate Map


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FLOOD INSURANCE STUDY

SALINE COUNTY,
UNINCORPORATED AREAS,
KANSAS

## 1.0 INTRODUCTION

### 1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the Unincorporated Areas of Saline County, Kansas, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates and assist the community in its efforts to promote sound flood plain management. Minimum flood plain management requirements for participation in the National Flood Insurance Program are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some states or communities, flood plain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the state (or other jurisdictional agency) will be able to explain them.

### 1.2 Authority and Acknowledgements

The sources of authority for this Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were performed by Bucher, Willis, & Ratliff, Consulting Engineers, Planners and Architects (the Study Contractor), for the Federal Emergency Management Agency (FEMA), under Contract No. H-4012. This study was completed in November 1982. Additional modifications were made by FEMA in January 1985.

### 1.3 Coordination

The identification of streams requiring detailed study was accomplished in a meeting held April 14, 1976, attended by representatives of FEMA, the Study Contractor, the Kansas Board of Agriculture, Division of Water Resources (KS Bd Ag-DWR), and the community. Subsequent coordination for this study included contact with the U.S. Geological Survey (USGS), the U.S. Army Corps of Engineers (COE), Kansas City District, the U.S. Department of Agriculture, Soil Conservation Service (SCS), the U.S. Bureau of Reclamation (USBR), the Kansas Water Office, the KS Bd Ag-DWR, the Salina Airport Authority, and Wilson & Company, Engineers and Architects (WCEA).



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On January 17, 1978, the reduction of discharges along Mulberry Creek downstream of the Interstate 70 structures was reviewed at a meeting between representatives of FEMA, the COE, the KS Bd Ag-DWR, and the Study Contractor. The decision was made to add detailed data for the Mulberry Creek Overflow to carry the Mulberry Creek flow diverted by the Interstate 70 embankment.

On February 9, 1978, preliminary flood elevations, flood boundaries, and floodway delineations for the detailed study streams outside of the Salina levee protection system were reviewed with representatives of the county, the Study Contractor, the KS Bd Ag-DWR, and FEMA at the intermediate meeting in Salina, Kansas.

On October 21, 1981, a technical meeting was held with representatives of Saline County, the Study Contractor, and FEMA to discuss a Special Problem Report and a major change of scope of the Flood Insurance Study, due to new FEMA levee policy. This new policy required a minimum levee freeboard of three feet and required, where credit was given to levees providing 100-year protection, that the adequacy of the interior drainage system be evaluated. The change of scope involved the interior drainage system and levee freeboard problems.

On December 2, 1981, new frequency curves for the USGS gage on Mulberry Creek at Salina, Kansas were reviewed by representatives of the Study Contractor, FEMA, and the COE at a meeting in Salina. The results of this gage analysis would be included as part of the Salina-Saline County Special Problem Report.

On June 10, 1982, a second technical meeting was held with representatives of the City of Salina, the Study Contractor, FEMA, and WCEA to review the status and results of the additional scope of work in Salina and Saline County.

During the afternoon of February 16, 1984, a working staff meeting was held in the Salina City Commission room to review the results of the City of Salina and Saline County Flood Insurance Studies. This meeting was attended by representatives of the City of Salina, Saline County, FEMA, the KS Bd Ag-DWR, and the Study Contractor. During the evening of February 16, 1984, the final public coordination meeting was held in the Salina Community Theater. The results of this Flood Insurance Study were reviewed and accepted at these meetings.

## 2.0 AREA STUDIED

### 2.1 Scope of Study

This Flood Insurance Study covers the unincorporated areas of Saline County, Kansas. The area of study is shown on the Vicinity Map (Figure 1). The incorporated areas within the county were excluded from this study.

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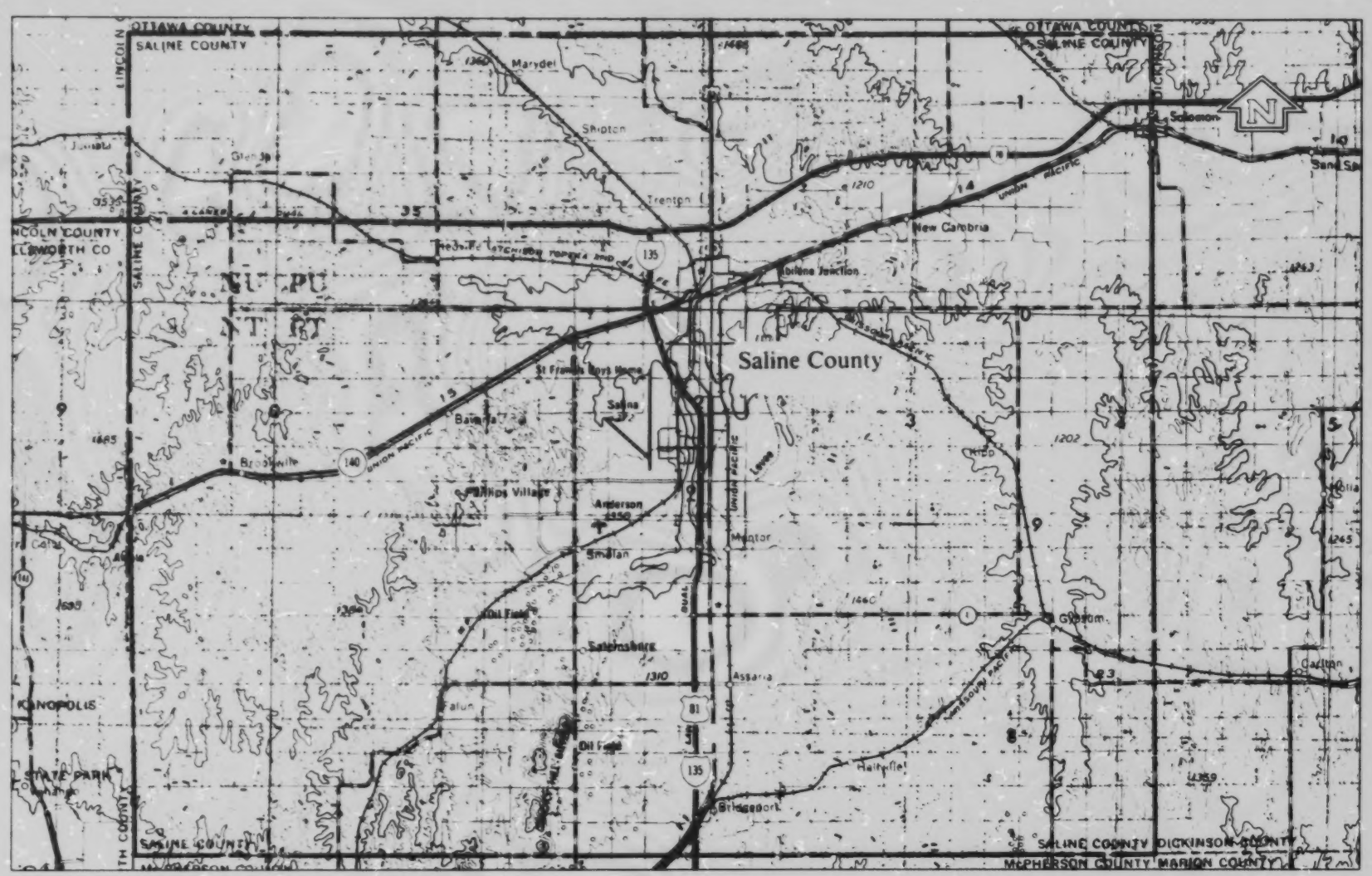


FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

**SALINE COUNTY, KS**

**(UNINCORPORATED AREAS)**

APPROXIMATE SCALE

4 0 4 8 12 MILES

**VICINITY MAP**

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Flooding caused by overflow of the following streams was studied in detail:

a. Smoky Hill River, from about 1,000 feet upstream of the confluence of the Solomon River to about 12,900 feet upstream of the confluence of the Solomon River, and from Niles Road to Maxwell Road near Mentor, Kansas;

b. Saline River, from its confluence with the Smoky Hill River to about 3.5 miles upstream of U.S. Highway 81;

c. Mulberry Creek, from its confluence with the Saline River to Burma Road;

d. Mulberry Creek Overflow, from its confluence with the Saline River to North 5th Street;

e. Dry Creek, from its confluence with Mulberry Creek to the Dry Creek Diversion Levee; and,

f. Dry Creek Diversion, from its confluence with the Smoky Hill River to just downstream of Interstate 135, about 1,200 feet upstream of State Highway 104.

Each of these streams runs along the riverside of the Salina levee protection system that the City of Salina sponsors, owns, and maintains. The local levee protection system land has been deemed part of the city even though the unincorporated portion of Saline County may be found on both sides of the levee system at many points (Reference 1).

Gypsum Creek was studied in detail from about 10,550 feet downstream of the Missouri Pacific Railroad to Assaria Road.

Gypsum Creek runs along the east side of the Gypsum levee protection system that the City of Gypsum sponsors, owns, and maintains. The water-surface profiles and 100-year flood boundary delineation were prepared during the design and construction stages of the levee system by the COE, Kansas City District. The COE data have been used in this study. No floodway calculations were made because the City of Gypsum, as local sponsor, was required to purchase flood easements on the ground submerged by the 100-year with-project flood.

Also studied in detail were the Solomon River, from about 2,300 feet upstream of its confluence with the Smoky Hill River to about 10,200 feet upstream of its confluence with the Smoky Hill River, and Magnolia Road Ditch, from its confluence with Dry Creek to about 1.68 miles upstream of Interstate 135. No floodway determination was made for this stream.

Approximate analyses were used to study those areas having a low development potential or minimal flood hazards.

Flooding on Smoky Hill River Tributary No. 1, Smoky Hill River Tributary No. 2, and Dry Creek Tributary No. 1 were studied by approximate methods.

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The flooding along the north and west sides of the Salina Municipal Airport was also studied by approximate methods. The remainder of the flood data for Saline County was transferred from the Saline County Flood Hazard Boundary Map (Reference 2) and a flood delineation map of the 1903 flood (Reference 3).

The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development or proposed construction through November 1987. The scope and methods of study were proposed to and agreed upon by FEMA and Saline County.

## 2.2 Community Description

Saline County is located in central Kansas, slightly north of the east-west axis of the state and approximately two-fifths of the distance from the eastern border to the western border of the state. The county is bordered on the east by Dickinson County, on the south by McPherson County, on the west by Ellsworth and Lincoln Counties, and on the north by Ottawa County. Salina, the county seat of Saline County, is approximately 176 miles west of Kansas City, 112 miles west of Topeka, and 90 miles north of Wichita. Saline County has a population of 48,905 (1980 census), which was a 5.0 percent increase from the 1970 census figure of 46,592 (Reference 4).

Two early attempts in 1856 and 1857 to establish a settlement in Saline County ended in failure. In 1858, the first permanent town site, Salina, was established by Colonel William A. Phillips with the help of A.M. Campbell and James Muir. At that time, all of the country west of the 6th Principal Meridian was unorganized territory, known as the Arrapahoe District. Saline County was included in this unorganized territory, but in February 1859, the territorial legislature passed a bill organizing and defining the boundary lines of five counties west of the 6th Principal Meridian, including Saline County. The great floods that occurred in 1858 washed away all the government bridges on the Smoky, Saline, and Solomon Rivers. The washing out of the bridges necessitated the laying out of a road on the south side of the Smoky Hill River from Salina to Wyandotte, a difficult, arduous task. When Saline County was organized, only 100 people located in and adjacent to Salina lived in the county. Few settled in the county until after the Civil War, although between 1860 and 1865, there were a few isolated settlements in different parts of the county. With the building of the Kansas Pacific Railway (Union Pacific Railroad) through Saline County in 1867, the rate of settlement increased. By 1870, the county population was 4,246, and by 1875, the population had increased to 6,360 (Reference 5).

The Saline County area has a continental climate with yearly precipitation varying from a low of 12.98 inches in 1966 to a high of 49.66 inches in 1951, and a yearly average precipitation of approximately 28.4 inches. On the average, more than 70 percent of the annual precipitation occurs from April through September, but monthly and seasonal precipitation can be very erratic. Precipitation during the summer is usually of the short-duration thunderstorm with small centers of high-intensity rainfall. The temperatures in the area range from a high of 118 degrees Fahrenheit (F.) in 1936 to a low of -31 degrees F. in 1905, with an average annual temperature of approximately 55.7 degrees F. (Reference 6).



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The topography of the western half of the county lies within the eroded zone along the eastern edge of the High Plains while the eastern half lies within the smoother, gently rolling Central Lowland area. The western upland areas among the headward eroding streams are remnants of the alluvial plain that once spread from the mountains on the west to the Central Lowlands. The eastern portion of the county is a plain of low relief, but two parts have greater relief than normal, the hills east of the Smoky Hill River and the divide between the Smoky Hill River and Gypsum Creek. The hills east of the Smoky Hill River are composed of wind-deposited materials from the valley floor. The divide between the Smoky Hill River and Gypsum Creek consists of erosion remnants similar to those in the western part of the county (Reference 7).

The county is drained by three major rivers and four large streams. The Smoky Hill River is the largest and enters the county from the south, flows north to the vicinity of Salina, and then follows an easterly course until it leaves the county. The Smoky Hill River has a drainage area of approximately 8,360 square miles at the Mentor USGS gage above the City of Salina, and has its headwaters in eastern Colorado. A drainage area of approximately 501 square miles is uncontrolled below the Kanopolis Dam and Reservoir. The Smoky Hill River flood plain averages about 2 miles in width.

Upstream of the Solomon River, the Smoky Hill River has a drainage area of approximately 11,937 square miles and an uncontrolled drainage area of approximately 2,163 square miles.

The Saline River enters the county from the north and flows southeastward until it empties into the Smoky Hill River northeast of Salina. The Saline River has a long, narrow basin with its headwaters in Thomas County, Kansas, and has a drainage area of approximately 3,280 square miles above the confluence of the Smoky Hill River. About 1,370 square miles of the drainage area are uncontrolled below Wilson Dam and Reservoir. The Saline River flood plain varies from 2.5 to 3 miles in width. The Smoky Hill and Saline Rivers share a common flood plain divided only by the Union Pacific tracks northeast of Salina.

The Solomon River flows across the northeastern corner of the county to its junction with the Smoky Hill River near the eastern county line. North and South Forks of the Solomon River rise within 10 miles of each other near the Sherman-Thomas county line in extreme western Kansas, and flow eastward to just west of Glen Elder, where the Solomon River is formed. The Solomon River has a drainage area of approximately 6,875 square miles at its confluence with the Smoky Hill River. Approximately 1,799 square miles of drainage area is uncontrolled below Glen Elder Dam and Waconda Lake.

In addition to the rivers, Mulberry, Spring, and Dry Creeks drain the western and southern parts of the county.

Mulberry Creek has a generally fan-shaped basin with its headwaters about 20 miles west of Salina in the eastern portions of Lincoln and Ellsworth Counties. It has a drainage area of approximately 290 square miles. Spring Creek is a tributary to Mulberry Creek.

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Dry Creek, as it is referred to in this study, is that portion of the original Dry Creek basin that is north of the Dry Creek Diversion levee and drains to Mulberry Creek along the western edge of Salina. Dry Creek drains the runoff from the eastern part of the Salina Municipal Airport and from south Salina. This portion of Dry Creek has a drainage area of approximately 30 square miles.

The remaining portion of Dry Creek that has been diverted south of Salina to the Smoky Hill River by the Dry Creek Diversion levee is referred to in this study as Dry Creek Diversion and has a drainage area of approximately 131 square miles. The Dry Creek Diversion drainage area is a fan-shaped basin with its headwaters in extreme northern McPherson County, in the Lindsborg-Marquette area.

Magnolia Road Ditch was constructed by the City of Salina to divert approximately 2.8 square miles of south Salina drainage to the Dry Creek channel, instead of allowing it to flow north, through Salina, to the Old Smoky Hill River channel.

The Old Smoky Hill River Channel has been cut off from the present channel by the Smoky Hill River levee. The three main runoff storage segments of the Old Smoky Hill River Channel are 1) the portion beginning at the Bill Burke Memorial Park (Lower Indian Rock Park) going through Kenwood and Oakdale Parks, past the eastern side of the Salina business district, to Lakewood Park, 2) the portion at the Old Holmquist sand pit area, just east of Albert Avenue and Mission Road, and 3) the portion at the Knox Sand Pit, east of Ohio Street and south of Magnolia Road.

The Old Dry Creek channel has been cut off from the present channel by the Dry Creek and Mulberry Creek levees and, generally, follows a south to north line along the western edge of Salina from about Beverly Drive and the Dry Creek levee to about Euclid Avenue and Thirteenth Street, extended north. The Old Dry Creek channel has been broken into two segments by the filling of the channel between South and Walnut Streets.

The southeastern and eastern parts of the county are drained by Gypsum Creek and its tributaries, another stream that flows northward to the Smoky Hill River. Gypsum Creek has its headwaters in the northeastern corner of McPherson County and has a drainage area of approximately 258 square miles at the Smoky Hill River.

Although agricultural employment involves a dwindling proportion of the population, agri-business still provides the foundation for a major portion of the county's economic production. Many manufacturing and commercial establishments are engaged in the production, sales, and/or servicing of farm implements, feed, and seed and grain elevators.

State and Federal highways cross the county, connecting it with other communities, cities, and trade areas. Interstate 70 runs east-west, approximately following the Smoky Hill River, Saline River, and Mulberry Creek. Interstate 135 transverses the county north to south. The Union Pacific System, the Oklahoma, Kansas, and Texas Railroad Company, and the



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Atchison, Topeka & Santa Fe Railway provide rail service in the county. The only inaccessible area in the county is a 52-square mile Restricted Military Area with no improved roads or residential areas to the southwest of the City of Salina.

The major portion of the City of Salina is situated on the broad alluvium flood plain with new residential and industrial development surrounding the existing corporate limits of Salina. The new residential development is generally to the south within the Salina levee system and on the rolling hills to the east of the Smoky Hill River, but other smaller development sites exist in the county surrounding Salina. While further development is discouraged in the flood plain, some selected sites may be possible on elevations in the floodway fringe area. Some businesses have been developed on the flood plain along Interstate 70 and Interstate 135, north and west of Salina. Most of the future urban growth in the county will probably occur in and around the existing incorporated areas.

## 2.3 Principal Flood Problems

A large portion of Saline County is located on the flood plains of the Smoky Hill, Saline, and Solomon Rivers and various creeks. The Salina Flood Protection Project completed in June 1961 and the Gypsum Flood Protection Project completed in May 1980 provide protection from the 100-year flood for a part of the county.

The flood season in central Kansas normally begins with the spring rains and continues through the summer. Snowmelt does not contribute appreciably to the flood situation. Past floodflows have usually been caused by a continuous precipitation pattern that lasts for several days associated with generalized storms over the basin. The low-lying areas near the streams in the county are also subject to periodic flooding caused by thunderstorms in the immediate vicinity and upper watersheds.

The most critical condition affecting the drainage problem is an extended period of above-normal rainfall ending with a high-intensity storm. A study of rainfall records indicates that an extended period of above-normal rainfall occurs every six or seven years. The occurrence of the high-intensity rainfall as the climax to a wet antecedent condition has occurred only twice in the period of precipitation record from 1880 to date, in 1903 and 1951. The 1903 storm was the largest storm recorded and has been considered to have a frequency interval of 100 years. The storm of July 9-12, 1951 has a frequency interval of about 50 years (Reference 8).

Data indicate a long history of flooding along streams in the Saline County area. Floods have occurred numerous times since 1844 when the first historical data were reported.

On the Smoky Hill River downstream of the confluences of the Solomon and Saline Rivers, the flood of May 22, 1877 was the highest flood since 1869 according to the May 25, 1977 Enterprise Kansas Gazette: "The Smoky has not been on such a bender since '69." The issue of June 2, 1877, describing flooding at Enterprise 30 miles downstream, stated, "The river rose last week 3 inches above the '69 mark."

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On the Smoky Hill River upstream of the confluence of the Saline River, the greatest known flood occurred in 1844. The Junction City Weekly Union, dated June 13, 1867, reported, "Water higher at Salina than it has been since the great flood of 1844. It was 4 feet higher at that time." The flood of August 1858 at Salina reached a stage about 5 feet lower than that of 1844. The July 10, 1895 flood at Salina was reported by the COE to have reached about the same stage as that of 1867. The second greatest known flood occurred on May 29, 1903 (Reference 9). The floods of August 1927 and June 1938 are possibly the third and fourth highest floods. The following is a list of the five largest annual peaks at the USGS gage on the Smoky Hill River near Mentor, Kansas.

| Year | Discharge (cubic feet per second (cfs)) | Estimated Frequency (years) |
|---|---|---|
| 1903 | 32,000 (estimated) | 100 |
| 1927 | 25,500 | 66 |
| 1938 | 24,000 | 57 |
| 1973 | 20,300 | 42 |
| 1951 | 20,000 | 40 |

On the Saline River, the flood of July 13, 1951 was the greatest known flood since May-June 1903 and exceeded that flood by about 1.0 foot from information supplied by Tescott residents (Reference 10). The following is a list of the five largest annual peaks recorded at the USGS gage on the Saline River at Tescott, Kansas:

| Year | Discharge (cfs) |
|---|---|
| 1951 | 61,400 |
| 1957 | 13,600 |
| 1961 | 12,900 |
| 1960 | 11,900 |
| 1973 | 9,800 |

The 1973 flood occurred after the completion of the Wilson Dam and Reservoir. No frequency analysis at the USGS gage at Tescott has been prepared since completion of the Wilson Dam. Tescott is located about 55 river miles upstream of Salina.

On the Solomon River, little is known of the early floods, but fragmentary records indicate that the flood of 1844 was probably comparable in magnitude to the 1951 flood. The following is a list of the five largest annual peaks at the USGS gage on the Solomon River at Niles, Kansas:

| Year | Discharge (cfs) | Estimated Frequency (years) |
|---|---|---|
| 1951 | 178,000 | 5,000 |
| 1974 | 52,400 | 110 |
| 1903 | 30,000 | 28 |
| 1973 | 28,500 | 24 |
| 1935 | 20,000 | 12 |



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Mulberry Creek can contribute significant flows to the Saline River north of Salina. These discharges would not be reflected in the gage record at Tescott. A USGS crest-stage partial-record station, Mulberry Creek near Salina, Kansas, has recorded stages since 1961. The following is a list of the five largest annual peaks at the USGS gage (Reference 10).

| Year | Discharge (cfs) | Estimated Frequency (years) |
|---|---|---|
| 1951 | 20,800 (estimated) | 80 |
| 1971 | 7,500 | 8 |
| 1961 | 7,200 | 8 |
| 1974 | 7,200 | 8 |
| 1973 | 7,000 | 7 |

Gypsum Creek has had a long history of flooding. More than one flood in a year is not unusual. The maximum stage known, since at least 1869, occurred on May 29, 1903. The most damaging floods of recent record occurred in October 1941 and July 1951. The 1929 flood was about the same magnitude as the 1941 and 1951 floods. A USGS gaging station, Gypsum Creek near Gypsum, Kansas, has recorded stages since 1955. The following is a list of the five largest annual peaks at the USGS gage (Reference 10).

| Year | Discharge (cfs) | Estimated Frequency (years) |
|---|---|---|
| 1965 | 11,400 | 12 |
| 1974 | 8,100 | 7 |
| 1955 | 6,900 | 5 |
| 1980 | 6,460 | 5 |
| 1973 | 5,360 | 4 |

The 1965 peak stage was 1.0 to 1.5 feet below the 1903, 1929, 1941, and 1951 stages.

The following excerpts from the Salina Journal pertain to some earlier floods as well as some of the more recent floods affecting the county area and indicate the continuing susceptibility of the area to flooding:

> May 26, 1903 - "The worst flood in the history of Salina is now raging and the entire portion of the city north of the Union Pacific and west of the Missouri Pacific tracks is entirely submerged. Portions of the city south of the Union Pacific tracks and west of Ninth Street, north of Ash are flooded and the waters are still rising." (Flooding from Mulberry Creek.)
>
> May 27, 1903 - "The rise yesterday was from Mulberry; the rise today is from Dry Creek. The waters in Mulberry have receded and the creek is only about half filled, but Dry Creek has taken a great rise since morning and the water is raging over the country southwest of the city taking a course along the tracks into the northern part of the city and is spreading rapidly over the low lands."

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August 17, 1927 - "Water on Dry Creek at State Street now is 10½ inches higher than at any other time this year. It has been at a standstill for 30 minutes at 3:15 o'clock."

June 6, 1938 - "When the Smoky Hill River broke over on South Ohio about 1:30 o'clock Sunday morning and started north toward Gypsum and Iron, east Salina knew there was trouble ahead. About the same time the dikes on Kansas and Penn began giving way."

October 19, 1941 - "As a forerunner of what is expected to be the worst flood ever to strike Salina, Dry Creek lashed through its banks south of the city early this morning to spill angry waters into the already bankfull Smoky Hill. Unable to find an outlet, creek waters overflowed into east Salina and swirled the length of Fifth and adjacent streets in a mill race."

October 20, 1941 - "Caught flat footed by a flood which mushroomed overnight to record proportions Salina stood knee deep in muddy water this afternoon from the troublesome Dry Creek watershed and waited apprehensively for what may yet come from up the Smoky Hill Valley. In four hours Salina's beleagured east side was flooded and water ran sidewalk deep through many parts of the business district.

By noon, from atop the United Life Building, half of Salina and all the surrounding country-side could be seen to resemble the land of 10,000 lakes. To the west flash floodwaters rolled down by Dry Creek and into low fields spreading out as wide as two miles."

July 11, 1951 - "County Engineers, Hal Everett's staff said they found a sheet of water starting two miles west of Salina and extending as far as they could see in the State Street road vicinity. They said it was water from the junction of Spring and Mulberry Creeks which join five miles west of the city."

July 12, 1951 - "The overflowing Smoky, still climbing, sent water over the entire east side."

"The north end went under as Dry Creek charged out of its banks and Mulberry Creek and Saline River backed up and flowed into town from the north."

"Dry Creek waters flooded west and northwest Salina too. Water from south of Salina drained into the draw in the southeast section of the city, overflowing it and flooding that area."

Friday, July 13, 1951 - "More than three-fourths of the city was under water Friday, but no casualities had been reported. In some areas overflows were reported dropping."

"It was estimated between 1500 and 2000 persons had fled their homes. The Smoky Hill River dropped two-tenths of an inch during the morning and at noon stood at 24.2 . But no one knew why."



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"But Salina isn't out of the woods and water yet. The furious Saline River, highest in history of north Salina, could back water into the already swollen Mulberry Creek and Dry Creek sending water into the north end."

May 23, 1971 - "The mighty little Mulberry Creek flexing its watery muscles after long years of placid living drove members of some 20 families from their homes west of Salina Saturday, then Saturday night began mauling parts of north Salina."

"Flooding severely in the wake of rains which measured up to 6.01 inches the Mulberry was threatening to close Highway US-81 at the north edge of Salina late Saturday night and had forced 4 to 5 more families to move out of their homes near North 5th Street Road and Stimmel Road east of US-81."

"Three service stations to the west side of US-81 and south of Interstate 70 were awash with several feet of water and the creek was lapping at the edge of the parking lot of the Mid-America Inn on the east side of 81."

"A dike on the south side of Mulberry protects most of Salina but persons living on the north side of the dike were at its mercy."

"Water from the Mulberry flowed down North 5th Street Road."

"There was one cheerful note, however, old time flood watchers said the Mulberry was not as high as it was in the Big Flood of 1951."

"However things have changed along the streams. The dike and Interstate 70 north of the creek probably have changed its patterns as have the numerous commercial developments along its banks near the intersection of Interstate 70 and US-81."

"US 40 Highway was closed to cars Monday afternoon one mile west of Salina. Overflowing Mulberry Creek covered an approach to a bridge west of the US 40-State Street Road intersection."

September 30, 1973 - "At Salina, Mulberry Creek yo-yoed down once more. There were no rains reported on the Mulberry and the creek appeared to be moving swiftly and falling Saturday afternoon. Thomas Park has reappeared and service stations in the Interstate 70-US 81 area which had been flooded were open. White Trucks and Steward International Harvester in the Truck Haven area continued surrounded by water."

October 11, 1973 - "Mulberry Creek was on its usual rampage and at noon was reported rising rapidly at Salina's north edge."

May 20, 1974 - "Mulberry Creek rose rapidly Sunday closing 5th Street Road and flooding areas near the US-81 and I-70 interchange. Thomas Park was under water and North Ohio Street was cut south of the I-70 interchange.

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Besides the riverine flooding of the Smoky Hill River, the Saline River, Mulberry Creek, Dry Creek, and Dry Creek Diversion, most of the area inside the Salina levee system can be flooded from intense local thunderstorms compounded by inadequate local drainage, as occurred in October 1973, April 1974, August-September 1977, and June 1981.

> "A portion of the existing drainage problem results from inadequate outlet discharge to and through the flood protection levee to the east of Salina and the inadequate drainage capacity of Dry Creek located to the west of Salina. Another portion of the problem consists of inadequate drains to the outlets."

> "Existing drainage systems within the city limits do not provide protection for a reasonable runoff rate; therefore, frequent flooding of streets and isolated vacant land areas occur. More, intense storms result in occasional physical property damage. As the urbanization of the area increases, the existing drainage systems will become less effective and difficult to maintain" (Reference 11).

On August 31 - September 1, 1977, a local high-intensity thunderstorm unofficially dumped as much as 8.0 inches of rainfall on southern Salina and the surrounding Saline County area. Extensive portions of the area were flooded.

> "It was August 31, 1977, when a freak storm began which left acres of South Salina flooded for several days. It took several days for the surface water to recede and gurgle its way to a sand pit east of the area." (Salina Journal)

> "A heavy thunderstorm early Thursday (June 11, 1981) that dumped nearly six inches in a three-hour period left Salina looking like Venice for a few hours."

> "Within a half-hour some streets were flooded. There also were many reports of water in basements."

> "Throughout the city, Salinans found themselves floundering in a sea of water following one of the biggest storms to hit the city since the fall of 1977." (Salina Journal)

## 2.4 Flood Protection Measures

A system of six flood control dams has been constructed on the Smoky Hill, Saline, and Solomon Rivers upstream of Saline County. Two of these reservoirs are on the Smoky Hill River. Cedar Bluff Dam and Reservoir has a drainage area of 5,530 square miles and began storage November 13, 1950. Kanopolis Dam and Reservoir, downstream of Cedar Bluff, has a drainage area of 7,860 square miles and began storage February 17, 1948. The crest elevation of the Kanopolis Dam uncontrolled emergency spillway is 1,507 feet National Geodetic Vertical Datum of 1929 (NGVD). The maximum pool elevation was 1,506.98 feet NGVD on July 14, 1951. One reservoir is on the Saline River. Wilson Dam and Reservoir has a drainage area of 1,720 square



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miles and began storage December 29, 1964. The remaining three reservoirs are in the Solomon River Basin. Kirwin Dam and Reservoir on North Fork Solomon River has a drainage area of 1,370 square miles and began storage September 19, 1955. Webster Dam and Reservoir on South Fork Solomon River has a drainage area of 1,150 square miles and began storage May 3, 1956. Glen Elder Dam and Waconda Lake, downstream of Kirwin and Webster, has a drainage area of 5,080 square miles and began storage January 1, 1969. All of these structures were on-line prior to the 1973-74 Water Year flood events on the Smoky Hill, Saline, and Solomon Rivers. "It should be noted, however, that the storms causing the 1903 and 1951 floods occurred substantially downstream from the reservoirs and a recurrence of these storms would still cause extensive inundation, particularly in the portion of the Smoky Hill River Valley in the vicinity of the confluence of the Saline and Solomon Rivers and downstream" (Reference 12).

Levees exist in the study area that provide the community with some degree of protection against flooding. However, it has been ascertained that some of these may not protect the community from rare events such as the 100-year flood. The criteria used to evaluate protection against the 100-year flood are 1) adequate design, including freeboard, 2) structural stability, and 3) proper operation and maintenance. Levees that do not protect against the 100-year flood are not considered in the hydraulic analysis of the 100-year flood plain.

The Salina Flood Protection Project completed in June 1961 provides protection for a large part of Salina and adjacent Saline County from external flooding sources. The flood control project includes the improvement of two miles of Mulberry Creek between North 9th Street and the Union Pacific Railroad bridge. The major portion of the Dry Creek drainage area has been diverted eastward into the Smoky Hill River through Dry Creek Diversion consisting of approximately two miles of diversion channel at a point south of Salina, near Mentor. The remaining downstream part of the Dry Creek channel has a length of approximately five miles. The reach between Interstate 135 and the Union Pacific Railroad bridge over Mulberry Creek has been straightened and leveed. The Smoky Hill River was improved by 4.4 miles of channel cutoffs and 4.3 miles of channel improvements. The City of Salina and surrounding area is protected from flooding on the Smoky Hill River, Mulberry Creek, Mulberry Creek Overflow, and Dry Creek by approximately 14 miles of levees.

Due to the lack of required freeboard along portions of the Mulberry and Dry Creek levees, the COE, Kansas City District, was asked to certify these levees for 100-year protection. In a letter dated October 18, 1982, the COE stated that Mulberry and Dry Creek levees "would still provide the initially designed 100-year frequency protection" (with no freeboard at West State Street).

The Gypsum Flood Protection Project completed in May 1980 provides protection for the City of Gypsum and the adjacent portion of Saline County from flooding along Gypsum, Spring, and Bull Run Creeks. The flood control project includes approximately 3.7 miles of levee with an average height of about 13 feet around the south, east, and north sides of the city; a 100-foot

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bottom width Spring Creek diversion channel to divert floodflows south of Gypsum from Spring Creek to Gypsum Creek; and, approximately 400 feet of channel clearing and widening in the vicinity of the Missouri Pacific Railroad bridge over Gypsum Creek.

Presently, four organized SCS watershed districts are located upstream of Saline County. Lost Creek Watershed, Salt Creek Watershed, Spillman Creek Watershed, and Fisher and Criss Creek Watershed. One additional watershed district, the Gypsum Creek Watershed, is proposed for Saline County (Reference 13).

Besides the above structural measures of flood protection, non-structural measures are being utilized to aid in the prevention of future flood damages. These measures are in the form of land use regulations that use the best available information to control further building within areas that have a high risk of flooding (Reference 14).

## 3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude that are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for flood plain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long-term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood that equals or exceeds the 100-year flood (1 percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

### 3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for each riverine flooding source studied in detail affecting the community.

The Hydrology Report for Dickinson County, Unincorporated Areas, Kansas (Reference 15) is the source of the 10-, 50-, 100-, and 500-year discharges at the USGS gages, Smoky Hill River at Enterprise, Kansas, and Smoky Hill River at New Cambria, Kansas. The discharges from the Enterprise gage were adjusted for change in drainage area. The adjusted discharges were used to determine flood profiles in the Smoky Hill River reach just upstream of the Saline-Dickinson county line. The Kansas Water Resources Board (KWRB) "Kansas Streamflow Characteristics, Magnitude and Frequency of



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Floods in Kansas, Regulated Streams, Interim Report" (Reference 16) was the source of the 10-, 50-, and 100-year discharges at the USGS gage, Smoky Hill River at New Cambria, Kansas. This gaging station is located at the beginning of the second detailed study reach along the Smoky Hill River. Discharges from the New Cambria gage site were used upstream to the confluence of the Saline River. The discharges for the gage, Smoky Hill River at New Cambria, Kansas, represent the flows in the Smoky Hill River channel and immediate flood plain, south of the Union Pacific Railroad tracks. Since the Saline River floodwaters, during periods as the 1951, 1973, and 1974 Water Year floods, only partially reached the Smoky Hill River at the Saline River confluence, the total flow in the combined Smoky Hill-Saline River valley would not be recorded at the gaging site. Thus, the total Smoky Hill valley 100-year discharge could easily be in the range of 70,000 to 80,000 cfs.

The COE Flood Plain Information (FPI) report for Salina, Kansas (Reference 17) served as the basis for the remaining portion of the Smoky Hill River, the Saline River, and the Dry Creek Diversion discharge-frequency relationships. Where flows were not given in the report or in the backup information, the 10- and 500-year discharges were determined from straight line extrapolation on a log-probability plot of the 25-, 50-, 75-, and 100-year discharge information.

The Saline River discharges were used upstream of the Union Pacific Railroad and Saline County Road structures over the Saline River just west of New Cambria. Downstream of the structures, the discharges were reduced to reflect their inadequacy to handle the flow. Separate rating curves were developed to balance the flow north of the railroad tracks with the flow passing through the structures. The flow north of the railroad tracks would continue moving northeastly until it joins the Solomon River, west of Solomon, Kansas. The reduction of flow along the Saline River downstream of the Union Pacific Railroad and Saline County Road structures was reviewed at a meeting in the FEMA Kansas City Offices on January 17, 1978, attended by representatives of FEMA, the COE, Kansas City District, the KS Bd Ag-DWR, and the Study Contractor. The decision was made that no detailed study would be performed for the diverted flow north of the Union Pacific Railroad and the City of New Cambria.

The Hydrology Report for the Unincorporated Areas of Dickinson County (Reference 15) was the source of the 10-, 50-, 100-, and 500-year discharges at the USGS gage, Solomon River at Niles. This site has been in continuous operation since October 1917. Values of the 10-, 50-, 100-, and 500-year peak discharges were obtained from log-Pearson U.S. Water Resources Council procedures (Reference 18) using 40 years of COE modified data adjusted with the 1903 flood.

The discharges for Mulberry Creek were revised from the values in the COE FPI report (Reference 19) by using the recorded gage information of the USGS gage, Mulberry Creek near Salina, Kansas (Reference 10). This gage, in the Saline County detailed study area, has a drainage area of 250 square miles, and has been in operation since Water Year 1961. The values of the

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10-, 50-, 100-, and 500-year peak discharges were obtained from a floodflow frequency analysis computer program based on the log-Pearson Type III distribution of annual peak discharges (References 18 and 20). The following modifications were made to the analysis: 1) an estimated historic flood (1951) was added to the data, and 2) a regional skew coefficient of -0.2 was used.

The discharges for Dry Creek were revised from the values in the COE FPI report (Reference 19) by using an SCS TR-20 model of the watershed. The discharges for Magnolia Road Ditch and The Slough were also determined using the SCS TR-20 model (Reference 21), which considers drainage area, soil type, land use, time of concentration, precipitation, in-channel storage, and timing of the hydrograph peaks (References 7, 22, and 23). Valley storage for flood routing was determined from HEC-2 (Reference 24) runs along the streams. The Dry Creek-Magnolia Road Ditch system is a very complex watershed. The Dry Creek hydrographs were peaking at Magnolia Road at approximately the same time as the Magnolia Road Ditch hydrographs were beginning to peak at Dry Creek. The Dry Creek discharges and water-surfaces would submerge the uncontrolled concrete box culvert under Interstate 135 and actually force Magnolia Road Ditch to flow backwaters into the levee-protected area of south Salina. Because the lower portion of Magnolia Road Ditch flows backwards at the same time the Magnolia Road Ditch hydrographs peak, the Magnolia Road Ditch flows break over the manmade watershed boundary, and flow north toward The Slough and east to the Old Smoky Hill River channel. It appears from TR-20 hydrograph modeling that the waters from Dry Creek flowing backward in Magnolia Road Ditch and the waters from Magnolia Road Ditch breaking over the watershed divide would not add significantly to The Slough peaks, but would extend the duration of flooding and would increase the volume of water to be handled by the Old Smoky Hill River channel. Before the construction of Magnolia Road Ditch, the runoff from this drainage area originally flowed north through a natural swale to The Slough channel. After the construction of this diversion ditch, a large portion of the natural swale was filled and developed into a residential area, south of Cloud Street.

In Table 1, the peak discharges for Mulberry Creek downstream of Interstate 70 were reduced to reflect the inadequacy of Interstate 70 structures to carry flows on downstream. Peak discharges for Magnolia Road Ditch downstream of the Union Pacific Railroad and Belmont Boulevard were reduced to reflect diversion of flows north and east into the city.

Gypsum Creek discharges in the Gypsum, Kansas area were taken from the COE Gypsum Flood Protection Project plans and reports, and from the court cases that followed involving the purchase of 100-year overflow easements. The design discharge for the levee system was 48,000 cfs. The listed 500-year discharge was the levee design overtopping flow.

The volume of required storage for the Old Smoky Hill River channel and the Old Dry Creek channel was calculated assuming 1) the streams outside the levee system were up (no gravity flow outlets open), 2) no pumping, and 3) the volume of runoff equal to the drainage area times the inches of direct runoff.



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Peak discharges for the 10-, 50-, 100-, and 500-year floods of each flooding source studied in detail in addition to the in-channel storage volumes for the ponding areas in the community are shown in Tables 1 and 2.

## 3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of the floods of the selected recurrence intervals.

Cross-section data for the Smoky Hill and Solomon Rivers in the vicinity of Solomon, Kansas; the Smoky Hill River from the beginning of the second detailed study reach to Indian Burial Pit Road; the Saline River from the Smoky Hill River through the Union Pacific Railroad and Saline County Road structures; and, the last two cross sections along the Saline River were obtained by field survey methods with supplemental data from the USGS topographic maps of the area (Reference 25). Bridges and culverts in these areas were field surveyed to obtain elevation data and structural geometry.

Cross-section data for the remainder of the Smoky Hill River, the remainder of the Saline River, Dry Creek Diversion, and Mulberry Creek were obtained from COE computer runs used in preparing the FPI report for Salina. The FPI cross sections were originally taken from USGS 7.5 minute, 10-foot contour intervals quadrangle sheets of the Salina area (Reference 26). Most bridge data were also obtained from the FPI computer runs and from the COE bridge plots. The Smoky Hill River bridge for Magnolia Road at the USGS stream gage was modified with information from the Smoky Hill River navigability study (Reference 27). The Saline River bridge profiles for Interstate 70 and 9th Street were modified to better reflect present road grade profiles. The Mulberry Creek bridges for 5th Street, 9th Street, the Union Pacific Railroad tracks and Interstate 135 were modified with field survey data. These modifications were necessary to better reflect present conditions.

Cross-section data for most of Dry Creek were obtained by field survey methods. Bridges and culverts were field surveyed to obtain elevation data and structural geometry. The remaining cross-section data for Dry Creek were obtained from the WCEA Salina Drainage Study (Reference 11).

Cross-section data for Gypsum Creek in the Gypsum, Kansas area was developed by the COE for the Gypsum levee protection system.

Cross-section data used to evaluate the in-channel storage volumes of the Old Smoky Hill River channel and the Old Dry Creek channel were obtained by field survey methods or digitized from aerial photos of the channels (Reference 28). Bridges and culverts were field surveyed to obtain elevation data and structural geometry.

Cross-section data for stream segments studied by approximate methods were developed from 10-foot USGS contour mapping (Reference 25).

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TABLE 1 - SUMMARY OF DISCHARGES

| FLOODING SOURCE AND LOCATION | DRAINAGE AREA SQ MILES | PEAK DISCHARGES (CFS) 10-YEAR | 50-YEAR | 100-YEAR | 500-YEAR |
|---|---|---|---|---|---|
| SMOKY HILL RIVER | | | | | |
| at USGS gage No. 06877600, Smoky Hill River at Enterprise, Kansas | 19,260<br>4,410[1] | 35,600 | 68,100 | 85,300 | 134,000 |
| just upstream of confluence of the Solomon River | 11,937<br>2,163[1] | 26,500 | 57,300 | 76,500 | 139,000 |
| at Saline County Road Bridge USGS gage No. 06870200, Smoky Hill River at New Cambria, Kansas | 11,666<br>1,892[1] | 15,500[2] | 34,000[2] | 45,500[2] | 82,000[2] |
| just upstream of confluence of the Saline River | 8,378<br>521[1] | 8,800 | 22,000 | 32,000 | 61,000 |
| at Iron Avenue | N/A | 8,800 | 22,000 | 32,000 | 61,000 |
| at Magnolia Road Bridge USGS gage No. 06866500, Smoky Hill River near Mentor, Kansas | 8,358<br>501[1] | 8,800 | 22,000 | 32,000 | 61,000 |
| SALINE RIVER | | | | | |
| just upstream of confluence with the Smoky Hill River | 3,283<br>1,366[1] | 10,300 | 15,700[3] | 19,800[3] | 30,000[3] |
| just upstream of Union Pacific Railroad and Saline County Road | 3,281<br>1,364[1] | 10,300 | 27,000 | 40,000 | 81,000 |
| at 9th Street Bridge (Alt. U.S. 81) | 2,977<br>1,060[1] | 10,300 | 27,000 | 40,000 | 81,000 |

[1]These numbers represent the uncontrolled drainage areas below the COE and USBR dams and reservoirs.

[2]These discharges represent the flow in the Smoky Hill River Channel and immediate flood plain south of the Union Pacific Railroad tracks. The flow in the entire Smoky Hill River Valley at the confluence of the Saline River would be greater.

[3]Discharges were reduced to reflect the inadequacy of structures to carry flow on downstream through the structures. The flow is diverted upstream of the structures.



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TABLE 1 - SUMMARY OF DISCHARGES (Continued)

| FLOODING SOURCE AND LOCATION | DRAINAGE AREA SQ MILES | PEAK DISCHARGES (CFS) 10-YEAR | 50-YEAR | 100-YEAR | 500-YEAR |
|---|---|---|---|---|---|
| SOLOMON RIVER | | | | | |
| just upstream of confluence with the Smoky Hill River | 6,875<br>1,799[1] | 19,100 | 40,000 | 52,400 | 91,400 |
| at USGS gage No. 06876900, Solomon River at Niles, Kansas | 6,770<br>1,694[1] | 18,300 | 38,600 | 50,700 | 89,100 |
| MULBERRY CREEK | | | | | |
| just downstream of Interstate 70 bridges | N/A | 5,850[3] | 7,950[3] | 9,100[3] | 12,450[3] |
| just upstream of 5th Street | N/A | 9,000 | 18,700 | 24,100 | 39,200 |
| at 9th Street | 287 | 9,000 | 18,700 | 24,100 | 39,200 |
| just upstream of confluence of Dry Creek | 256 | 8,480 | 17,600 | 22,700 | 37,000 |
| at USGS gage No. 06869950, near Salina, Kansas | 250 | 8,380 | 17,400 | 22,400 | 36,500 |
| MULBERRY CREEK OVERFLOW | | | | | |
| at Ohio Street | N/A | 3,150 | 10,750 | 15,000 | 26,750 |
| DRY CREEK | | | | | |
| at Union Pacific Railroad and Saline County Road | 29.6 | 4,270 | 6,190 | 6,930 | 8,600 |
| just upstream of State Street Road | 14.1 | 2,180 | 3,110 | 3,460 | 4,200 |
| at Crawford Street | 13.5 | 2,230 | 3,250 | 3,650 | 4,600 |
| at Interstate 135 | 13.1 | 2,430 | 3,510 | 3,930 | 4,880 |
| at Missouri Pacific Railroad | 9.50 | 1,520 | 2,190 | 2,460 | 3,060 |
| at Magnolia Road | 6.32 | 1,450 | 2,100 | 2,360 | 2,960 |
| at Schilling Road | 5.43 | 1,290 | 1,880 | 2,120 | 2,690 |
| at Water Well Road | 2.79 | 938 | 1,360 | 1,530 | 1,930 |

[1]These numbers represent the uncontrolled drainage areas below the COE and USBR dams and reservoirs.

[2]These discharges represent the flow in the Smoky Hill River Channel and immediate flood plain south of the Union Pacific Railroad tracks. The flow in the entire Smoky Hill River Valley at the confluence of the Saline River would be greater.

[3]Discharges were reduced to reflect the inadequacy of structures to carry flow on downstream through the structures. The flow is diverted upstream of the structures.

TABLE 1 - SUMMARY OF DISCHARGES (Continued)

| FLOODING SOURCE AND LOCATION | DRAINAGE AREA SQ MILES | PEAK DISCHARGES (CFS) 10-YEAR | 50-YEAR | 100-YEAR | 500-YEAR |
|---|---|---|---|---|---|
| DRY CREEK DIVERSION | | | | | |
| just upstream of confluence with the Smoky Hill River | 131 | 4,000 | 11,000 | 16,000 | 37,000 |
| at Old US 81 Bridge, USGS gage No. 06866490, Dry Creek at Mentor, Kansas | 94.7 | 4,000 | 11,000 | 16,000 | 37,000 |
| GYPSUM CREEK | | | | | |
| at Missouri Pacific Railroad | 179 | 9,300 | 21,000 | 32,500 | 75,000 |
| MAGNOLIA ROAD DITCH | | | | | |
| at Interstate 135 | 2.80 | 271 | 390 | 407 | 438 |
| just downstream of Union Pacific Railroad and Belmont Boulevard | 1.95 | 191 | 208 | 266 | 166 |
| flow diverted into city | N/A | 0 | 149 | 211 | 362 |
| just upstream of Union Pacific Railroad and Belmont Boulevard | 1.95 | 176 | 264 | 301 | 392 |
| flow west through Bonnie Ridge Subdivision | N/A | 165 | 248 | 284 | 366 |
| flow east through Bonnie Ridge Subdivision to South Ohio Street | N/A | 55 | 88 | 102 | 136 |
| at southern edge of Bonnie Ridge Subdivision | 1.77 | 220 | 336 | 385 | 501 |



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TABLE 2 - SUMMARY OF STORAGE AREAS

| FLOODING SOURCE AND LOCATION | DRAINAGE AREA SQUARE MILES | PRESENT IN-CHANNEL STORAGE BETWEEN COE DESIGN ELEVATIONS (AC-FT) | ESTIMATED 100-YEAR STORM RUNOFF (AC-FT) |
|---|---|---|---|
| Old Smoky Hill River Channel<br>Bill Burke Park to Lakewood Park | 5.41 | 1,160 | 1,610 + seepage |
| Old Smoky Hill River Channel<br>Bill Burke Park to Lakewood Park<br>(includes overflow from<br>Magnolia Road Ditch) | 9.11 | 1,160 | 2,710 + seepage |
| Old Smoky Hill River Channel<br>Holmquist Sand Pit Area | 1.67 | 162 (COE) | 478 + seepage |
| Old Smoky Hill River Channel<br>Knox Sand Pit Area | 1.52 | 80 (COE)<br>180 (WCEA) | 454 + seepage |
| Old Dry Creek Channel (north)<br>Walnut Street North to Mulberry<br>Creek Levee | 1.98 | 116 | 590 (no seepage) |
| Old Dry Creek Channel (south)<br>South Street to Dry Creek Levee | 0.91 | 22 | 270 (no seepage) |

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles. For stream segments for which a floodway was computed (Section 4.2), selected cross-section locations are also shown on the Flood Boundary and Floodway Map.

Roughness coefficients (Manning's "n") for all streams were estimated by field inspection, aerial photographs of the Saline County area (References 28, 29, 30, and 31), and FPI computer runs. The range of roughness coefficients for the main channel and the remainder of the flood plain for each stream studied in detail are shown below.

| Flooding Source | Manning's "n" Channel | Overbank |
|---|---|---|
| Smoky Hill River | 0.030 - 0.043<br>0.022 (COE) | 0.045 - 0.100<br>0.050 (COE) |
| Saline River | 0.035 - 0.040<br>0.022 (COE) | 0.075 - 0.080<br>0.050 (COE) |
| Solomon River | 0.033 - 0.043 | 0.045 - 0.080 |
| Mulberry Creek | 0.080 - 0.090 | 0.060 |
| Mulberry Creek Overflow | 0.060 | 0.060 |
| Dry Creek | 0.035 - 0.050 | 0.050 - 0.070 |
| Dry Creek Diversion | 0.022 (COE) | 0.050 (COE) |
| Old Smoky Hill River Channel | 0.045 | 0.060 |
| Old Dry Creek Channel | 0.045 | 0.075 |

Water-surface profiles for all detailed study streams were developed using the HEC-2 step-backwater computer program (Reference 24). The starting water-surface elevations for the Smoky Hill River in the Solomon area were determined from a continuous HEC-2 run from Enterprise, Kansas used in the Dickinson County Flood Insurance Study (Reference 15 and 32). The starting elevations for the Solomon River at its confluence were determined from the backwater calculations on the Smoky Hill River. Comparison of the computer profiles with the 1974 Water Year high water marks indicated a reasonable modeling of the streams. The starting water-surface elevations for the second detailed study reach of the Smoky Hill River were estimated by extrapolation of the USGS gage rating curve at the Smoky Hill River at New Cambria, Kansas gage. The extrapolated USGS gage rating curve at Smoky Hill River near Mentor, Kansas was used to check the profile runs. Reasonable agreement was achieved at this second site. The starting water-surface elevations for the Saline River at its confluence were determined from the backwater calculations on the Smoky Hill River.



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Comparison of the computed profiles with the 1951 and 1973 high water marks in the New Cambria area indicated a reasonable modeling of the streams. The starting water-surface elevations for Mulberry Creek, Mulberry Creek Overflow, Dry Creek, and Dry Creek Diversion were determined using the slope-area method. The extrapolated USGS gage rating curve at Mulberry Creek near the Salina, Kansas gage was used to check the Mulberry Creek profile runs, and reasonable agreement was achieved.

Mulberry Creek Overflow, from Mulberry Creek to the Saline River south of Interstate 70, was established to carry the excess discharge that the Interstate 70 structures would not handle at each frequency and water-surface elevation. This natural overflow will reduce the water-surface elevations immediately upstream of the Interstate 70 structures. The stream distances used were measured along a natural swale for hydraulic modeling purposes. The FPI report for Mulberry Creek assumed all flows would pass through the Interstate 70 structures over Mulberry Creek to the Saline River.

The Gypsum Creek profiles were prepared by the COE for the design and overflow easement acquisition of the Gypsum levee system. The 500-year profile was for a discharge of 75,000 cfs, the levee design overtopping flow.

The in-channel storage and pumping facilities for the Old Smoky Hill River channel and the Old Dry Creek channel were designed for a 25-year design storm. The present in-channel storage volume of the Old Smoky Hill River channel between elevations 1,203 and 1,216 feet NGVD appears to match the usable temporary 25-year design storage volume between elevations 1,203 and 1,216 feet NGVD, but to handle the 100-year storage requirement, additional storage volume is necessary. The present in-channel storage volume of the Old Dry Creek channel between elevations 1,207.0 and 1,217.0 feet NGVD appears to be only one-third of the temporary 25-year design storage volume between the same elevations. Thus, additional storage volume is necessary, and ponding will occur in low areas that are drained by storm sewers to the Old Dry Creek channel.

The available data indicate that the 500-year water-surface profiles would overtop the Salina levee system along Dry Creek Diversion and Dry Creek.

Flood profiles were drawn showing the computed water-surface elevations for floods of the selected recurrence intervals.

Areas of the community inside the levees were delineated using more detailed internal drainage analysis.

The hydraulic analyses for this study are based only on the effects of unobstructed flow. The flood elevations shown on the profiles are, thus, considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

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All elevations are referenced to the NGVD. Elevation reference marks used in this study are shown on the maps.

## 4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages state and local governments to adopt sound flood plain management programs. Therefore, each Flood Insurance Study produces maps designed to assist communities in developing flood plain management measures.

### 4.1 Flood Boundaries

To provide a national standard without regional discrimination, the 1 percent annual chance (100-year) flood has been adopted by FEMA as the base flood for flood plain management purposes. The 0.2 percent annual chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the 100- and 500-year flood plain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using USGS topographic maps at a scale of 1:24000, with a contour interval of 10 feet (Reference 25). Along the Old Dry Creek channel, the available mapping was inadequate to show the low areas that would flood if the 100-year storage elevations are reached. The excess runoff from the 100-year storm would pond in the industrial, commercial, and residential districts located east of the Old Dry Creek channel. The remainder of the area inside the Salina levee system has been shown as 500-year flood plain, due to 1) the Dry Creek and Dry Creek Diversion levees being overtopped by the 500-year flow, 2) the area being protected from the 100-year riverine flooding by the Salina levee system but still subject to flooding from failure or overtopping during a larger flood (residual risk of flooding), and 3) the areas being subject to 100-year shallow flooding where average depths are less than 1.0 foot, or where the contributing drainage area is less than 1.0 square mile.

For each stream studied in the Gypsum area, the boundaries of the 100-year flood have been delineated using the COE 100-year flood boundaries and 2-foot project mapping. The COE 100-year ponding areas have been delienated using the COE-calculated 100-year water-surface elevations and the COE project mapping. The remainder of the area inside of the Gypsum levee system has been shown as 500-year flood plain, due to the area being protected from 100-year riverine flooding by the levee system but still subject to flooding from failure or overtopping during a larger flood (residual risk of flooding).

Flood boundaries for the approximate study areas were delineated on these maps using slope-area calculations, past historical data, and the Saline County and the City of Salina Flood Hazard Boundary Maps (References 2 and 33).

The blocking of bridge or culvert openings, or the plugging of storm sewers during a period of storm runoff could result in the flooding of areas outside those shown by these flood delineation lines.



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For the streams studied by approximate methods only the 100-year flood plain boundary is shown.

The 100- and 500-year flood plain boundaries are shown on the Flood Boundary and Floodway Map. In cases where the 100- and 500-year flood plain boundaries are close together, only the 100-year flood plain boundary has been shown. Small areas within the flood plain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

## 4.2 Floodways

Encroachment on flood plains, such as structures and fill, reduces the flood-carrying capacity, increases the flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the National Flood Insurance Program, a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood plain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream plus any adjacent flood plain areas that must be kept free of encroachment so that the 100-year flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced.

The floodways for the portions of the Smoky Hill River downstream of the Salina levee system, the Saline River, Mulberry Creek Overflow, part of Mulberry Creek, and part of Dry Creek were computed on the basis of equal conveyance reductions for each side of the flood plain and then adjusted, as necessary, to try to maintain a 1.0-foot increase in elevation over the 100-year water-surface elevation. Since a majority of the Smoky Hill River east of Salina flows between the levee on the left bank and higher ground on the right bank, the floodway shown is the effective area necessary to carry the 100-year flood with no increase in flood elevations as determined from the COE cross-section data. Along the Dry Creek Diversion south of Salina, the 100-year flood remains essentially in the improved channel. Thus, no floodway calculations were made, and all the Dry Creek Diversion channel was designated as floodway. The Mulberry Creek Overflow floodway was designed to carry that portion of the 100-year floodflow that would not pass through Interstate 70 structures over Mulberry Creek. No increase in the floodway elevation over the 100-year water-surface elevation was allowed along Mulberry Creek between 5th Street and 9th Street and along Dry Creek in the vicinity of State Street Road and downstream, due to the lack of the required 3 to 4 feet of levee freeboard. Just upstream of State Street Road and Crawford Street, the total 100-year flood plain along Dry Creek was designated as floodway to preserve the overbank valley storage used in the TR-20 model to reduce the size of the discharges as the flow moved downstream. In the vicinity of Magnolia Road along Dry Creek, a minimal flood increase in floodway elevation over the 100-year water-surface elevation was allowed, due to the fact that any increase in elevation would increase the backwater flow of Magnolia Road Ditch through the

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uncontrolled concrete box culvert under Interstate 135 and into the levee-protected area of Salina. No floodway was computed for the overflow area north of the Union Pacific Railroad and Saline County Road that would normally carry a large part of the 100-year floodflow of the Saline River in the New Cambria area. As per the meeting on January 17, 1978, attended by representatives of FEMA, the COE, Kansas City District, the KS Bd Ag-DWR, and the Study Contractor, it was decided that no floodway would be calculated or determined for the area north of the Union Pacific tracks because the land use was primarily agricultural and there was very little relief with minimal slope.

No floodways were computed for the flooding sources in the Gypsum, Kansas area because the City of Gypsum as local sponsor for the local flood protection system was required to purchase 100-year overflow easements in the affected area of the project. The flood easement line was the 100-year with project flood plain. The results of these computations were tabulated at selected cross sections for each stream segment for which a floodway was computed and are presented in Table 3, Floodway Data.

As shown on the Flood Boundary and Floodway Map, the floodway boundaries were computed at cross sections. Between cross sections, the boundaries were interpolated. In cases where the floodway and the 100-year flood plain boundaries are either close together or collinear, only the floodway boundary has been shown.

The area between the floodway and the 100-year flood plain boundaries is termed the floodway fringe. The floodway fringe thus encompasses the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain development are shown in Figure 2.

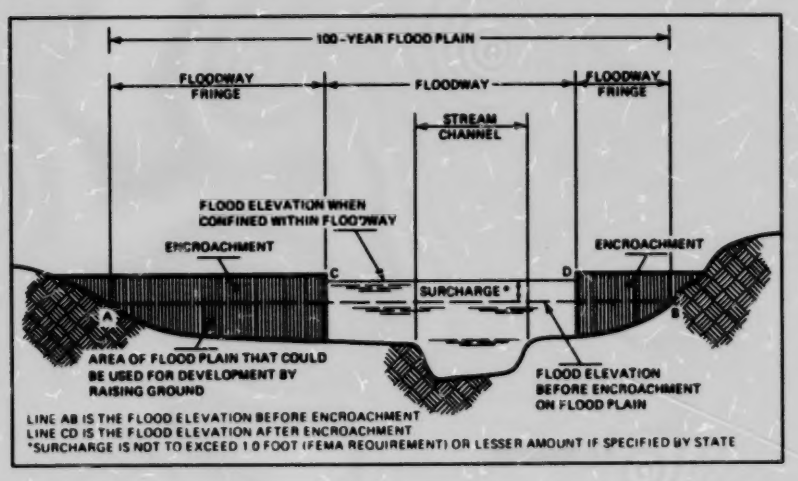
100-YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE *
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE AB IS THE FLOOD ELEVATION BEFORE ENCROACHMENT
LINE CD IS THE FLOOD ELEVATION AFTER ENCROACHMENT
*SURCHARGE IS NOT TO EXCEED 1.0 FOOT (FEMA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE

FIGURE 2 - Floodway Schematic



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| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER SURFACE ELEVATION | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE[1] | WIDTH (FEET) | SECTION AREA (SQ. FEET) | MEAN VELOCITY (FEET/SEC.) | REGULATORY (FEET NGVD) | WITHOUT FLOODWAY (FEET NGVD) | WITH FLOODWAY (FEET NGVD) | INCREASE (FEET) |
| SMOKY HILL RIVER | | | | | | | | |
| A | 3010 | 4802[2] | 31,119 | 2.5 | 1170.5 | 1170.5 | 1171.5 | 1.0 |
| B | 12,920 | 7160 | 38,816 | 2.0 | 1172.9 | 1172.9 | 1173.9 | 1.0 |
| C | 108,585 | 1900 | 19,601 | 2.3 | 1195.6 | 1195.6 | 1196.6 | 1.0 |
| D | 116,835 | 3000[3] | 24,841 | 1.8 | 1197.9 | 1197.9 | 1198.9 | 1.0 |
| E | 132,655 | 4700 | 31,499 | 1.0 | 1199.6 | 1199.6 | 1200.2 | 0.6 |
| F | 154,394 | 1350 | 12,006 | 2.7 | 1205.8 | 1205.8 | 1206.8 | 1.0 |
| G | 157,034 | 260 | 3920 | 8.2 | 1205.8 | 1205.8 | 1206.8 | 1.0 |
| H | 163,949 | 926[4] | 5924 | 5.4 | 1216.3 | 1216.3 | 1216.7 | 0.4 |
| I | 154,533 | 510[4] | 3969 | 8.1 | 1216.8 | 1216.8 | 1217.2 | 0.4 |
| J | 175,097 | 1061[2] | 13,217 | 2.4 | 1234.0 | 1234.0 | 1234.0 | 0.0 |
| K | 178,793 | 1403[2] | 10,016 | 3.2 | 1234.4 | 1234.4 | 1234.4 | 0.0 |
| L | 183,017 | 1266[4] | 5693 | 5.6 | 1237.0 | 1237.0 | 1237.0 | 0.0 |
| M | 184,601 | 1120[4] | 7758 | 4.1 | 1238.1 | 1238.1 | 1238.1 | 0.0 |
| N | 187,274 | 1169 | 7816 | 4.1 | 1240.4 | 1240.4 | 1240.4 | 0.0 |
| O | 189,914 | 2081[4] | 8030 | 4.0 | 1242.4 | 1242.4 | 1242.4 | 0.0 |
| P | 194,138 | 2325 | 7231 | 4.4 | 1244.0 | 1244.0 | 1244.0 | 0.0 |
| Q | 194,930 | 2551 | 9801 | 3.3 | 1245.1 | 1245.1 | 1245.1 | 0.0 |
| R | 200,499 | 2370 | 10,912 | 2.9 | 1247.2 | 1247.2 | 1247.2 | 0.0 |
| S | 218,451 | 1847 | 9787 | 3.3 | 1253.8 | 1253.8 | 1253.8 | 0.0 |
| T | 221,091 | 2827 | 15,289 | 2.1 | 1254.5 | 1254.5 | 1254.8 | 0.3 |

[1]FEET ABOVE CONFLUENCE OF SOLOMON RIVER
[2]THIS WIDTH EXTENDS BEYOND COUNTY BOUNDARY
[3]COMBINED FLOODWAY WIDTH OF SMOKY HILL RIVER AND SALINE RIVER
[4]ADMINISTRATIVE WIDTH TO INCLUDE LEVEE

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

**SALINE COUNTY, KS**
**(UNINCORPORATED AREAS)**

**FLOODWAY DATA**

28

**SMOKY HILL RIVER**

| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER SURFACE ELEVATION | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE[1] | WIDTH (FEET) | SECTION AREA (SQ. FEET) | MEAN VELOCITY (FEET/SEC.) | REGULATORY (FEET NGVD) | WITHOUT FLOODWAY (FEET NGVD) | WITH FLOODWAY (FEET NGVD) | INCREASE (FEET) |
| SALINE RIVER | | | | | | | | |
| A | 3700 | 3000[2] | 24,841 | 1.8 | 1197.9 | 1197.9 | 1198.9 | 1.0 |
| B | 15,896 | 2430 | 19,717 | 1.1 | 1199.6 | 1199.6 | 1200.3 | 0.7 |
| C | 17,332 | 800 | 5246 | 4.2 | 1200.7 | 1200.7 | 1201.7 | 1.0 |
| D | 21,117 | 1814 | 9494 | 4.2 | 1201.3 | 1201.3 | 1202.3 | 1.0 |
| E | 25,341 | 2841 | 24,162 | 1.7 | 1203.4 | 1203.4 | 1204.4 | 1.0 |
| F | 45,435 | 2600 | 20,438 | 2.0 | 1207.4 | 1207.4 | 1208.3 | 0.9 |
| G | 62,859 | 1550 | 8220 | 4.9 | 1212.6 | 1212.6 | 1213.6 | 1.0 |
| H | 68,597 | 1972 | 10,937 | 3.7 | 1217.8 | 1217.8 | 1218.8 | 1.0 |
| I | 72,403 | 2640 | 28,232 | 1.4 | 1219.5 | 1219.5 | 1220.5 | 1.0 |
| J | 79,856 | 4950 | 29,289 | 1.4 | 1225.0 | 1225.0 | 1225.9 | 0.9 |
| K | 85,136 | 4250 | 26,946 | 1.5 | 1225.4 | 1225.4 | 1226.4 | 1.0 |
| L | 95,696 | 3500 | 29,157 | 1.4 | 1227.0 | 1227.0 | 1228.0 | 1.0 |
| M | 115,422 | 4300 | 21,130 | 1.9 | 1233.9 | 1233.9 | 1234.8 | 0.9 |
| N | 124,668 | 4505 | 20,640 | 1.9 | 1236.5 | 1236.5 | 1237.5 | 1.0 |

[1]FEET ABOVE CONFLUENCE WITH SMOKY HILL RIVER
[2]COMBINED FLOODWAY WIDTH OF SMOKY HILL RIVER AND SALINE RIVER

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TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

**SALINE COUNTY, KS**

**(UNINCORPORATED AREAS)**

**FLOODWAY DATA**



**SALINE RIVER**

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| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER SURFACE ELEVATION | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE[1] | WIDTH (FEET) | SECTION AREA (SQ. FEET) | MEAN VELOCITY (FEET/SEC.) | REGULATORY (FEET NGVD) | WITHOUT FLOODWAY (FEET NGVD) | WITH FLOODWAY (FEET NGVD) | INCREASE (FEET) |
| SOLOMON RIVER | | | | | | | | |
| A | 9914[2] | 2750 | 19,622 | 2.7 | 1171.6 | 1171.6 | 1172.6 | 1.0 |
| MULBERRY CREEK | | | | | | | | |
| A | 2700 | 1800 | 5967 | 1.5 | 1219.5 | 1217.1[4] | 1217.5 | 0.4 |
| B | 7800 | 3000[3] | 15,656 | 0.6 | 1219.5 | 1217.6[4] | 1218.2 | 0.6 |
| C | 16,047 | 4550[5] | 27,411 | 0.9 | 1225.1 | 1225.1 | 1225.1 | 0.0 |
| D | 19,017 | 2660[5] | 18,955 | 1.3 | 1225.5 | 1225.5 | 1225.5 | 0.0 |
| E | 20,742 | 850[5] | 9302 | 2.6 | 1225.8 | 1225.8 | 1225.9 | 0.1 |
| F | 21,761 | 1000[5] | 8820 | 2.7 | 1226.9 | 1226.9 | 1227.2 | 0.3 |
| G | 23,041 | 1200[5] | 9174 | 2.6 | 1227.6 | 1227.6 | 1228.0 | 0.4 |
| H | 27,716 | 1850 | 14,152 | 1.6 | 1230.3 | 1230.3 | 1231.2 | 0.9 |
| I | 28,876 | 1020 | 9213 | 2.5 | 1230.6 | 1230.6 | 1231.6 | 1.0 |
| J | 30,730 | 800 | 7945 | 2.8 | 1232.6 | 1232.6 | 1233.6 | 1.0 |
| K | 31,854 | 1660 | 8768 | 2.6 | 1234.1 | 1234.1 | 1235.1 | 1.0 |
| L | 33,584 | 2750 | 12,932 | 1.7 | 1235.6 | 1235.6 | 1236.6 | 1.0 |
| M | 37,564 | 3500 | 20,418 | 1.1 | 1236.8 | 1236.8 | 1237.8 | 1.0 |
| N | 42,583 | 1879 | 15,659 | 1.4 | 1237.9 | 1237.9 | 1238.9 | 1.0 |
| O | 44,683 | 825 | 7353 | 3.0 | 1238.6 | 1238.6 | 1239.6 | 1.0 |

[1]FEET ABOVE CONFLUENCE WITH SALINE RIVER
[2]FEET ABOVE CONFLUENCE WITH SMOKY HILL RIVER
[3]THIS WIDTH EXTENDS BEYOND COUNTY BOUNDARY
[4]ELEVATIONS WITHOUT CONSIDERING BACKWATER EFFECT FROM SALINE RIVER
[5]ADMINISTRATIVE WIDTH TO INCLUDE LEVEE

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

**SALINE COUNTY, KS**
**(UNINCORPORATED AREAS)**

**FLOODWAY DATA**

30 **SOLOMON RIVER—MULBERRY CREEK**

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| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER SURFACE ELEVATION | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE[1] | WIDTH (FEET) | SECTION AREA (SQ. FEET) | MEAN VELOCITY (FEET/SEC.) | REGULATORY (FEET NGVD) | WITHOUT FLOODWAY (FEET NGVD) | WITH FLOODWAY (FEET NGVD) | INCREASE (FEET) |
| MULBERRY CREEK OVERFLOW | | | | | | | | |
| A | 5130 | 671 | 4826 | 3.1 | 1206.4 | 1205.1[3] | 1206.1 | 1.0 |
| B | 6660 | 810 | 4972 | 3.0 | 1207.0 | 1206.9[3] | 1207.9 | 1.0 |
| C | 9320 | 770 | 4111 | 3.6 | 1210.5 | 1210.5 | 1211.4 | 0.9 |
| D | 12,090 | 1310 | 6836 | 2.2 | 1212.7 | 1212.7 | 1213.7 | 1.0 |
| E | 13,350 | 1770 | 7115 | 2.1 | 1213.9 | 1213.9 | 1214.8 | 0.9 |
| F | 14,830 | 2900 | 15,727 | 1.0 | 1214.4 | 1214.4 | 1215.4 | 1.0 |
| G | 19,170 | 2425 | 9275 | 1.6 | 1215.7 | 1215.7 | 1216.7 | 1.0 |
| H | 20,490 | 2800[2] | 6739 | 2.2 | 1217.4 | 1217.4 | 1218.1 | 0.7 |

[1]FEET ABOVE CONFLUENCE WITH SALINE RIVER
[2]THIS WIDTH EXTENDS WITHIN INCORPORATED AREAS
[3]ELEVATIONS WITHOUT CONSIDERING OVERFLOW EFFECT FROM SALINE RIVER

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

**SALINE COUNTY, KS**
**(UNINCORPORATED AREAS)**

**FLOODWAY DATA**



**MULBERRY CREEK OVERFLOW**

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| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER SURFACE ELEVATION | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE[1] | WIDTH (FEET) | SECTION AREA (SQ. FEET) | MEAN VELOCITY (FEET/SEC.) | REGULATORY (FEET NGVD) | WITHOUT FLOODWAY (FEET NGVD) | WITH FLOODWAY (FEET NGVD) | INCREASE (FEET) |
| DRY CREEK | | | | | | | | |
| A | 4751 | 1690[4] | 4077 | 1.7 | 1229.8 | 1226.2[3] | 1226.2 | 0.0 |
| B | 6053 | 1950[4] | 2181 | 3.2 | 1229.9 | 1227.1[3] | 1227.1 | 0.0 |
| C | 6709 | 4015[2] | 2081 | 3.3 | 1230.0 | 1229.0[3] | 1229.0 | 0.0 |
| D | 7420 | 4300[2,4] | 4685 | 0.7 | 1230.7 | 1230.7 | 1230.7 | 0.0 |
| E | 9520 | 3640[2,4] | 18,744 | 0.2 | 1230.8 | 1230.8 | 1230.8 | 0.0 |
| F | 11,380 | 150[2,4] | 999 | 3.5 | 1230.8 | 1230.8 | 1230.8 | 0.0 |
| G | 13,356 | 500[2,4] | 1539 | 2.4 | 1231.7 | 1231.7 | 1232.0 | 0.3 |
| H | 13,616 | 950[4] | 9348 | 0.4 | 1231.8 | 1231.8 | 1232.1 | 0.3 |
| I | 15,316 | 500[4] | 4995 | 0.7 | 1231.9 | 1231.9 | 1232.2 | 0.3 |
| J | 16,816 | 200[4] | 904 | 4.0 | 1231.9 | 1231.9 | 1232.2 | 0.3 |
| K | 17,916 | 300[4] | 844 | 4.3 | 1233.1 | 1233.1 | 1233.3 | 0.2 |
| L | 18,468 | 200[4] | 749 | 4.9 | 1234.2 | 1234.2 | 1234.3 | 0.1 |
| M | 22,226 | 220 | 1290 | 3.0 | 1238.4 | 1238.4 | 1238.6 | 0.2 |
| N | 22,670 | 1920 | 2153 | 1.1 | 1239.1 | 1239.1 | 1239.3 | 0.2 |
| O | 23,880 | 2225 | 2496 | 1.0 | 1239.6 | 1239.6 | 1239.7 | 0.1 |
| P | 26,324 | 139 | 809 | 2.9 | 1241.4 | 1241.4 | 1241.7 | 0.3 |
| Q | 28,024 | 133 | 896 | 2.6 | 1242.1 | 1242.1 | 1242.6 | 0.5 |
| R | 29,529 | 72 | 636 | 3.7 | 1243.0 | 1243.0 | 1243.6 | 0.6 |
| S | 33,618 | 77 | 652 | 3.3 | 1244.5 | 1244.5 | 1245.1 | 0.6 |
| T | 37,838 | 149 | 876 | 1.7 | 1246.6 | 1246.6 | 1247.1 | 0.5 |
| U | 40,273 | 156 | 956 | 1.4 | 1247.1 | 1247.1 | 1247.5 | 0.4 |
| V | 42,273 | 137 | 782 | 0.7 | 1247.3 | 1247.3 | 1247.8 | 0.5 |
| W | 43,080 | 100 | 2391 | 0.2 | 1252.5 | 1252.5 | 1253.0 | 0.5 |
| X | 46,690 | 60 | 707 | 0.4 | 1252.6 | 1252.6 | 1253.1 | 0.5 |

[1]FEET ABOVE CONFLUENCE WITH MULBERRY CREEK
[2]THIS WIDTH EXTENDS BEYOND COUNTY BOUNDARY
[3]ELEVATIONS WITHOUT CONSIDERING OVERFLOW EFFECT FROM MULBERRY CREEK
[4]ADMINISTRATIVE WIDTH TO INCLUDE LEVEE

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

**SALINE COUNTY, KS**

**(UNINCORPORATED AREAS)**

**FLOODWAY DATA**

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**DRY CREEK**

| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER SURFACE ELEVATION | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE[1] | WIDTH (FEET) | SECTION AREA (SQ. FEET) | MEAN VELOCITY (FEET/SEC.) | REGULATORY (FEET NGVD) | WITHOUT FLOODWAY (FEET NGVD) | WITH FLOODWAY (FEET NGVD) | INCREASE (FEET) |
| DRY CREEK DIVERSION | | | | | | | | |
| A | 2640 | 104 | 1401 | 11.4 | 1256.6 | 1256.6 | 1256.6 | 0.0 |
| B | 4785 | 250[2] | 1663 | 9.6 | 1259.3 | 1259.3 | 1259.3 | 0.0 |
| C | 7976 | 480[2] | 1876 | 8.9 | 1261.7 | 1261.7 | 1261.7 | 0.0 |
| D | 10,807 | 115 | 1535 | 10.4 | 1263.9 | 1263.9 | 1263.9 | 0.0 |

[1]FEET ABOVE CONFLUENCE WITH SMOKY HILL RIVER
[2]ADMINISTRATIVE WIDTH TO INCLUDE LEVEE

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The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

## 5.0 INSURANCE APPLICATION

To establish actuarial insurance rates, data from the engineering study must be transformed into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors, and flood insurance zone designations for each flooding source studied in detail affecting Saline County.

### 5.1 Reach Determinations

Reaches are defined as sections of flood plain that have relatively the same flood hazard, based on the weighted average difference in water-surface elevations between the 10- and 100-year floods. This difference may not have a variation greater than that indicated in the following table for more than 20 percent of the reach:

| Average Difference Between 10- and 100-year Floods | Variation |
|---|---|
| Less than 2 feet | 0.5 foot |
| 2 to 7 feet | 1.0 foot |
| 7.1 to 12 feet | 2.0 feet |
| More than 12 feet | 3.0 feet |

The locations of the reaches determined for the riverine flooding sources of Saline County are shown on the Flood Profiles and are summarized in Table 4, Flood Insurance Zone Data.

### 5.2 Flood Hazard Factors

The Flood Hazard Factor (FHF) is used to establish relationships between depth and frequency of flooding in any reach. This relationship is then used with depth-damage relationships for various classes of structures to establish actuarial insurance rate tables.

The FHF for a riverine reach is the weighted average difference between the 10- and 100-year flood water-surface elevations rounded to the nearest 0.5 foot, multiplied by 10, and shown as a 3-digit code. For example, if the difference between elevations is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference is greater than 10.0 feet, it is rounded to the nearest whole foot.

### 5.3 Flood Insurance Zones

Flood insurance zones and zone numbers are assigned based on the type of flood hazard and the FHF, respectively. A unique zone number is associated with each possible FHF and varies from 1 for a FHF of 005 to a maximum of 30 for a FHF of 200 or greater.

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| | |
|---|---|
| Zone A: | Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations are shown or FHFs determined. |
| Zone AH: | Special Flood Hazard Areas inundated by types of 100-year shallow flooding where depths are between 1.0 and 3.0 feet; base flood elevations are shown, but no FHFs are determined. |
| Zones A1, A3, A5-A9 A12, A17, A20: | Special Flood Hazard Areas inundated by the 100-year flood, with base flood elevations shown, and zones subdivided according to FHFs. |
| Zone B: | Areas between the Special Flood Hazard Areas and the limits of the 500-year flood; areas that are protected from the 100- and 500-year floods by dike, levee, or other water control structure; areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and, areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided. |
| Zone C: | Areas of minimal flooding; not subdivided. |

Flood elevation differences, FHFs, flood insurance zones, and base flood elevations for each flooding source studied in detail in the community are shown in Table 4, Flood Insurance Zone Data.

### 5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for Saline County is, for insurance purposes, the principal product of the Flood Insurance Study. This map contains the official delineation of flood insurance zones and base flood elevation lines. Base flood elevation lines for riverine flooding sources show the locations of the expected whole-foot water-surface elevations of the base (100-year) flood. The base flood elevations and zone numbers are used by insurance agents, in conjunction with structure elevations and characteristics, to assign actuarial insurance rates to structures and contents insured under the National Flood Insurance Program.

## 6.0 OTHER STUDIES

The National Weather Service (formerly the U.S. Department of Commerce, Weather Bureau) review of the 1951 flood published flood profile information on the Smoky Hill, Saline, and Solomon Rivers within Saline County (Reference 34). The COE, during the design of the Saline levee protection project, prepared the Design Memorandum that was the source of the original interior drainage design information and drainage area boundaries (Reference 8).



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| FLOODING SOURCE | PANEL[1] | ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND | | | FLOOD HAZARD FACTOR | ZONE | BASE FLOOD ELEVATION[3] (FEET NGVD) |
|---|---|---|---|---|---|---|---|
| | | 10% (10-YEAR) | 2% (50-YEAR) | 0.2% (500-YEAR) | | | |
| SMOKY HILL RIVER | | | | | | | |
| REACH 1 | 0025 | −3.0 | −0.8 | 1.7 | 030 | A6 | VARIES—SEE MAP |
| REACH 2 | 0025,0060 | −3.8 | −1.1 | 2.5 | 040 | A8 | VARIES—SEE MAP |
| REACH 3 | 0060 | −5.3 | −1.3 | 3.3 | 060 | A12 | VARIES—SEE MAP |
| REACH 4 | 0060 | −10.0 | −3.9 | 8.0 | 100 | A20 | VARIES—SEE MAP |
| REACH 5 | 0060,0080 | −6.2 | −1.6 | 4.7 | 060 | A12 | VARIES—SEE MAP |
| SALINE RIVER | | | | | | | |
| REACH 1 | 0025,0055,0060, 0065 | −3.8 | −1.0 | 3.4 | 040 | A8 | VARIES—SEE MAP |
| SOLOMON RIVER | | | | | | | |
| REACH 1 | 0025 | −3.3 | −0.8 | 1.6 | 035 | A7 | VARIES—SEE MAP |
| MULBERRY CREEK | | | | | | | |
| REACH 1 | 0065,0070 | −3.6 | −1.2 | 2.1 | 035 | A7 | VARIES—SEE MAP |
| REACH 2 | 0070 | −2.6 | −0.7 | 1.6 | 025 | A5 | VARIES—SEE MAP |
| MULBERRY CREEK OVERFLOW | | | | | | | |
| REACH 1 | 0055,0060 | −2.7 | −0.7 | 1.5 | 025 | A5 | VARIES—SEE MAP |
| REACH 2[4] | 0055,0060,0070 | −3.8 | −1.0 | 3.4 | 040 | A8 | VARIES—SEE MAP |

[1]FLOOD INSURANCE RATE MAP PANEL
[2]WEIGHTED AVERAGE
[3]ROUNDED TO NEAREST FOOT
[4]DATA FOR THIS REACH TAKEN FROM THE CITY OF SALINA, KS. FLOOD INSURANCE STUDY

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

**SALINE COUNTY, KS**

**(UNINCORPORATED AREAS)**

## FLOOD INSURANCE ZONE DATA



**SMOKY HILL RIVER—SALINE RIVER—SOLOMON RIVER—MULBERRY CREEK—MULBERRY CREEK OVERFLOW—**

| FLOODING SOURCE | PANEL[1] | ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND | | | FLOOD HAZARD FACTOR | ZONE | BASE FLOOD ELEVATION[3] (FEET NGVD) |
|---|---|---|---|---|---|---|---|
| | | 10% (10-YEAR) | 2% (50-YEAR) | 0.2% (500-YEAR) | | | |
| DRY CREEK | | | | | | | |
| REACH 1 | 0070,0090 | −2.7 | −0.7 | 1.5 | 025 | A5 | VARIES—SEE MAP |
| DRY CREEK DIVERSION | | | | | | | |
| REACH 1 | 0080,0090 | −8.5 | −2.1 | 8.1 | 085 | A17 | VARIES—SEE MAP |
| GYPSUM CREEK | | | | | | | |
| REACH 1 | 0030,0040 | −3.1 | −1.2 | 2.8 | 030 | A6 | VARIES—SEE MAP |
| REACH 2 | 0030,0035,0040, 0045 | −4.5 | −2.1 | 6.6 | 045 | A9 | VARIES—SEE MAP |
| REACH 3 | 0035,0045 | −1.5 | −0.5 | 4.2 | 015 | A3 | VARIES—SEE MAP |
| MAGNOLIA ROAD DITCH | | | | | | | |
| REACH 1 | 0060 | −0.3 | −0.1 | 0.2 | 005 | A1 | VARIES—SEE MAP |

[1]FLOOD INSURANCE RATE MAP PANEL
[2]WEIGHTED AVERAGE
[3]ROUNDED TO NEAREST FOOT

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TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

**SALINE COUNTY, KS**
**(UNINCORPORATED AREAS)**

## FLOOD INSURANCE ZONE DATA

**DRY CREEK—**
**DRY CREEK DIVERSION—GYPSUM CREEK—MAGNOLIA ROAD DITCH**

The COE "Flood Plain Information-Smoky Hill River, Kansas, Salina to the Mouth near Junction City" study published low water, "flood stage," modified 25-year flood, actual July 1951 flood, and modified standard project flood stream profiles on the Smoky Hill River (Reference 12). The COE "Flood Plain Information, Smoky Hill River, Saline River, Dry Creek Diversion, Salina, Kansas" study (Reference 17) and the COE "Flood Plain Information, Mulberry Creek, Dry Creek, Salina, Kansas" study (Reference 19) served as the main source of the basic data for this Flood Insurance Study. Numerous adjustments were necessary to the effective flow areas and the structural cross sections to represent present conditions.

The KWRB Interim Report on regulated streams (Reference 16) served as the source of discharge information along the Smoky Hill River at New Cambria. The COE, during design of the Gypsum Levee protection project, prepared several studies that were sources of the flood information at Gypsum along Gypsum Creek.

The Mulberry Creek and Dry Creek discharges were revised, and Mulberry Creek Overflow was added to the analysis. Due to the critical effects of Dry Creek on Salina drainage, Dry Creek was field surveyed. These flood elevations and boundaries will be different from those shown in these FPI studies.

WCEA has prepared 2-foot contour mapping of parts of south Salina (Reference 35) and has prepared the South Salina Drainage Study (Reference 11) for the City of Salina to review and make recommendations concerning the inadequate internal drainage of southern Salina and surrounding Saline County.

Flood Insurance Studies have been published for the Cities of Solomon and Gypsum, and for the Unincorporated Areas of McPherson County (References 36, 37, and 38). Flood Insurance Studies for Dickinson County and the Cities of Salina and New Cambria, are currently in progress (References 32, 39, and 40). All of these studies match the Saline County study.

Due to its more detailed analysis, this Flood Insurance Study supersedes the previously printed Flood Hazard Boundary Map for Saline County (Reference 2).

## 7.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, Federal Emergency Management Agency, Federal Office Building, Room 305, 911 Walnut Street, Kansas City, Missouri 64106.

## 8.0 REFERENCES AND BIBLIOGRAPHY


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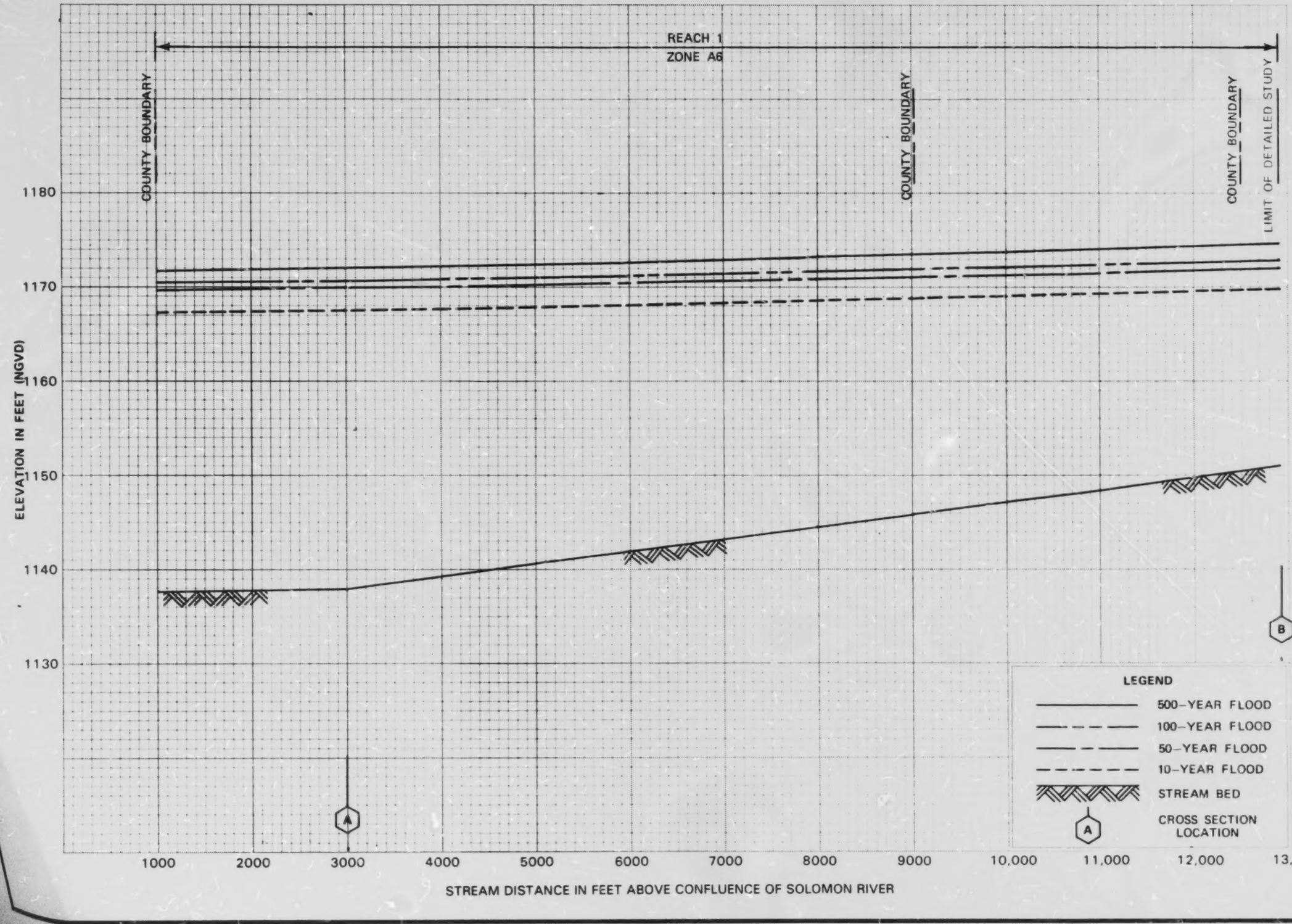


FLOOD PROFILES

SMOKY HILL RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

SALINE COUNTY, KS
(UNINCORPORATED AREAS)

01P



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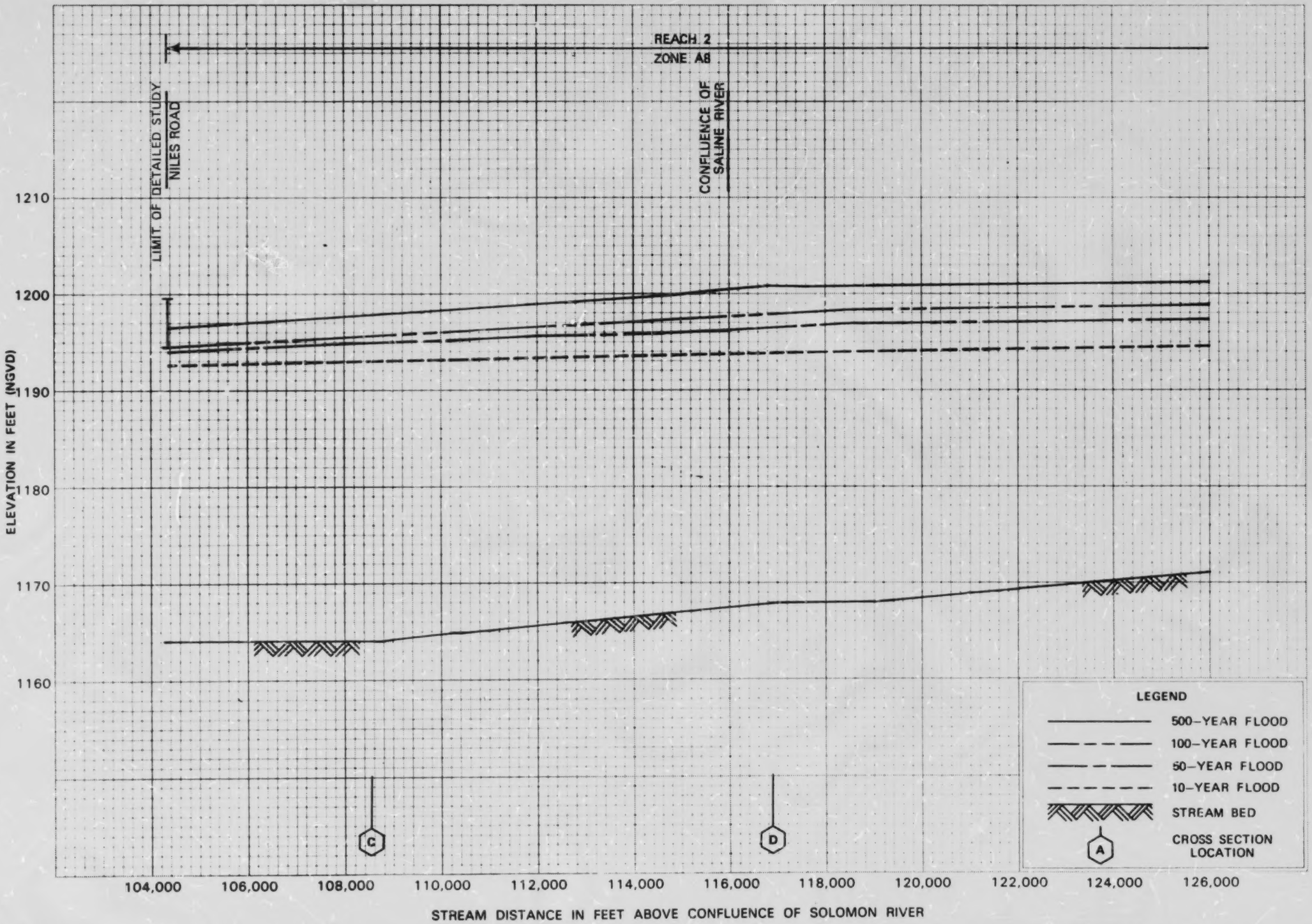


FLOOD PROFILES

SMOKY HILL RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

SALINE COUNTY, KS
(UNINCORPORATED AREAS)

02P



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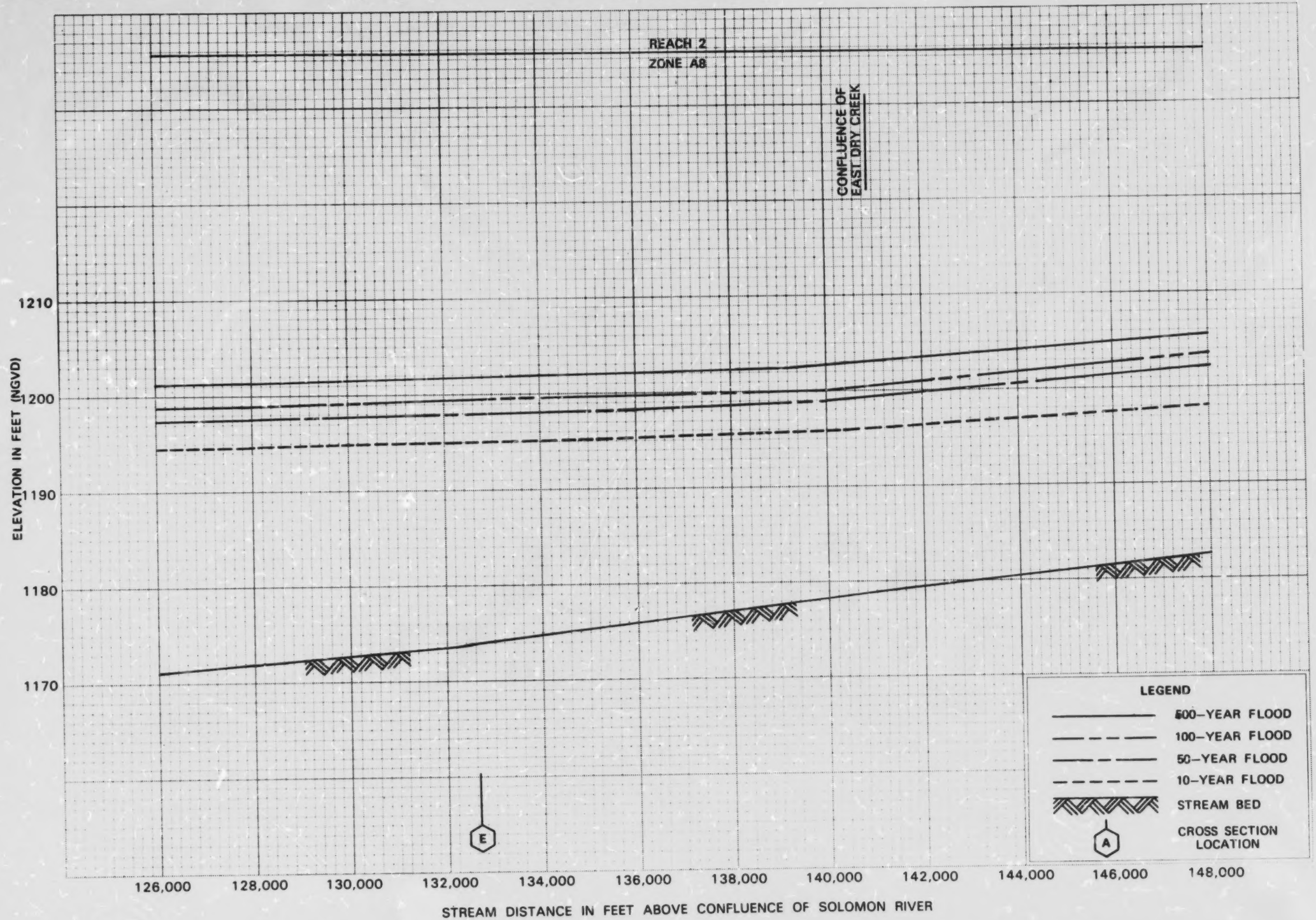


FLOOD PROFILES

SMOKY HILL RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

SALINE COUNTY, KS
(UNINCORPORATED AREAS)

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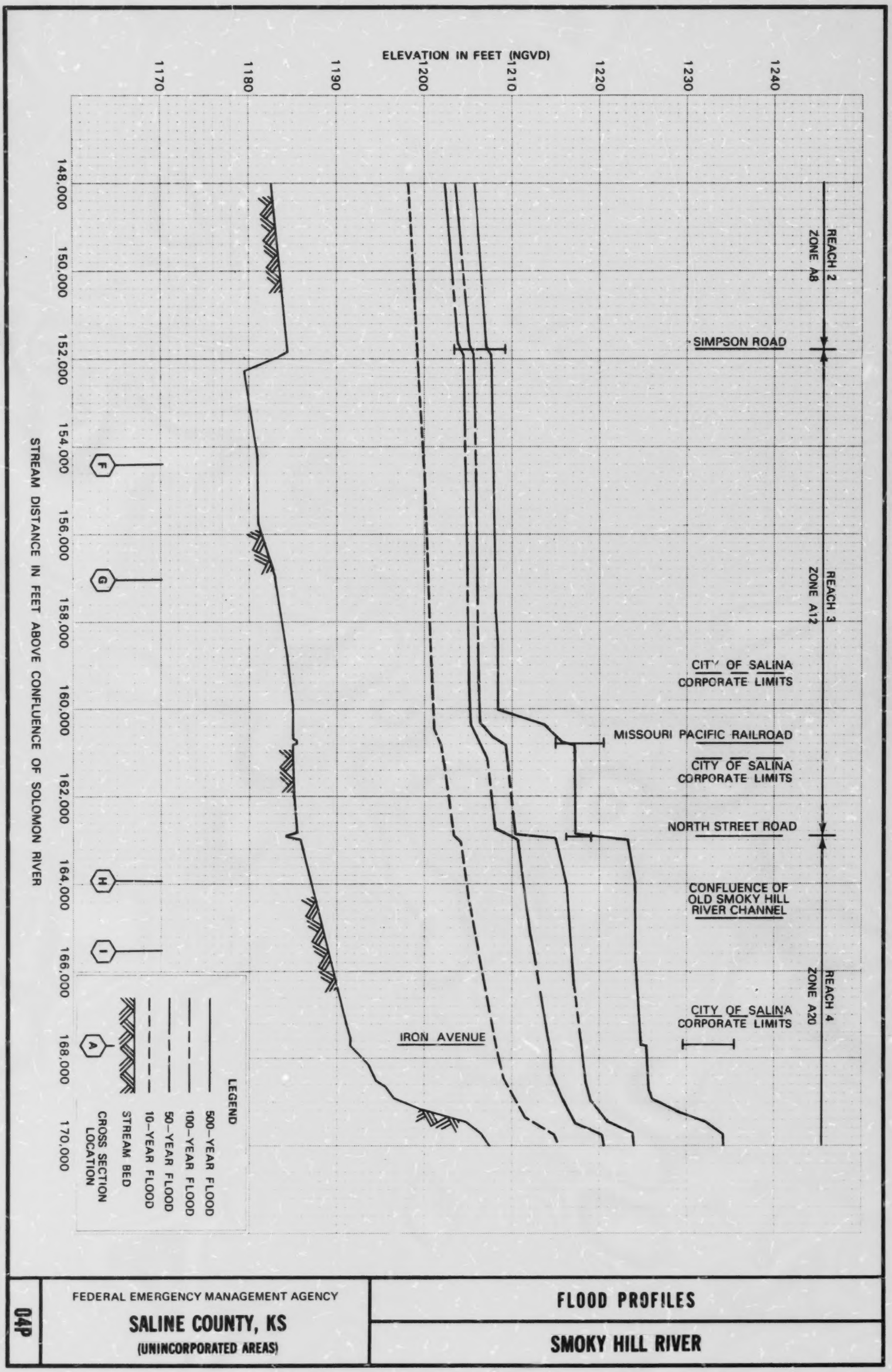


FEDERAL EMERGENCY MANAGEMENT AGENCY

**SALINE COUNTY, KS**

**(UNINCORPORATED AREAS)**

**FLOOD PROFILES**

**SMOKY HILL RIVER**

04P

46

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REACH 4
ZONE A20

REACH 5
ZONE A12

CRAWFORD STREET

CITY OF SALINA
CORPORATE LIMITS

CONFLUENCE OF
SMOKY HILL RIVER
TRIBUTARY NO. 2

CITY OF SALINA
CORPORATE LIMITS

MAGNOLIA ROAD

ELEVATION IN FEET (NGVD)

1260
1250
1240
1230
1220
1210
1200

J K L M N O

LEGEND

500–YEAR FLOOD
100–YEAR FLOOD
50–YEAR FLOOD
10–YEAR FLOOD
STREAM BED
A — CROSS SECTION LOCATION

170,000 172,000 174,000 176,000 178,000 180,000 182,000 184,000 186,000 188,000 190,000 192,000

STREAM DISTANCE IN FEET ABOVE CONFLUENCE OF SOLOMON RIVER

FLOOD PROFILES

SMOKY HILL RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

SALINE COUNTY, KS
(UNINCORPORATED AREAS)

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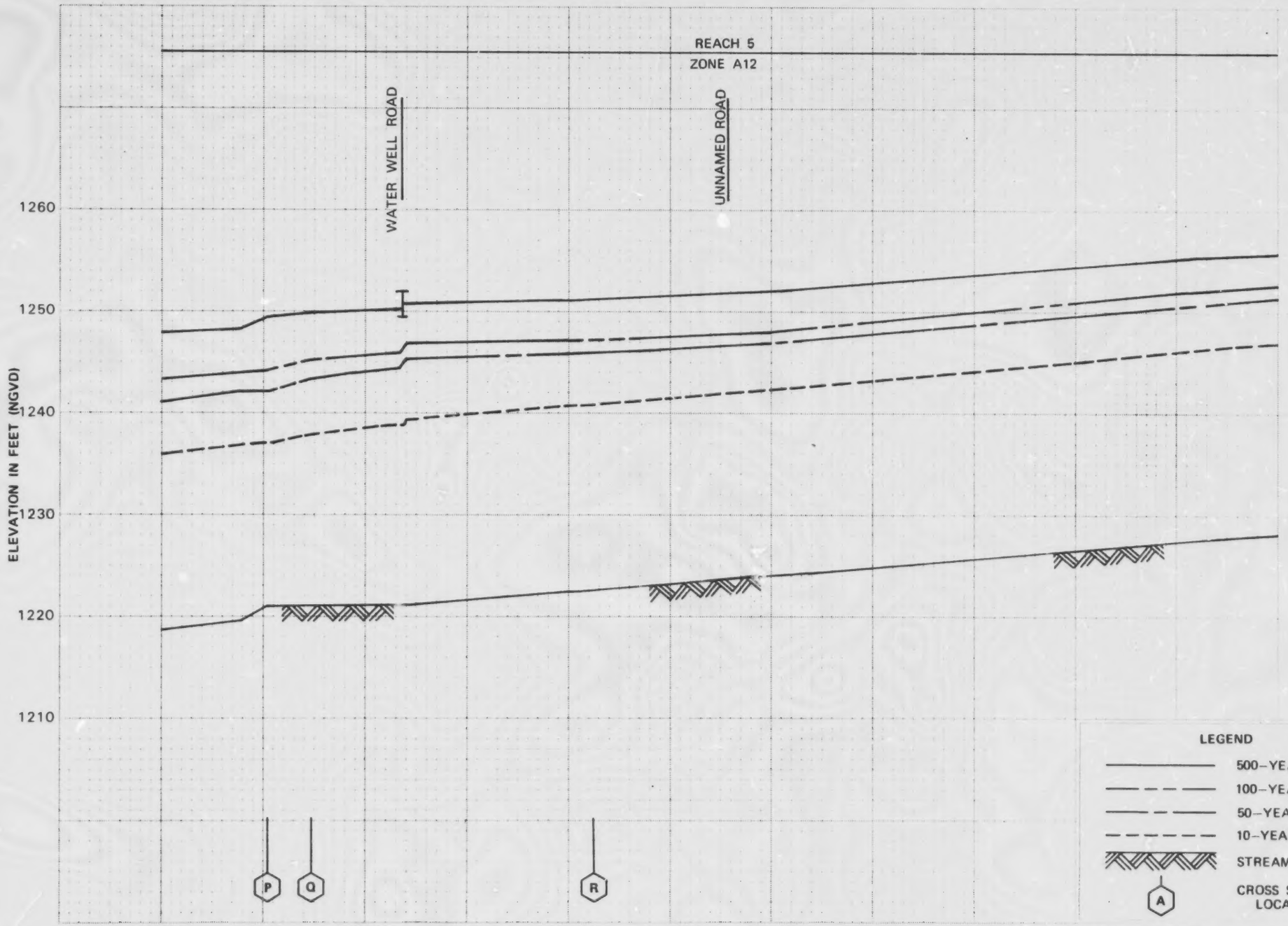


FLOOD PROFILES

SMOKY HILL RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

SALINE COUNTY, KS
(UNINCORPORATED AREAS)

06P



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FLOOD PROFILES

SMOKY HILL RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

SALINE COUNTY, KS
(UNINCORPORATED AREAS)

07P



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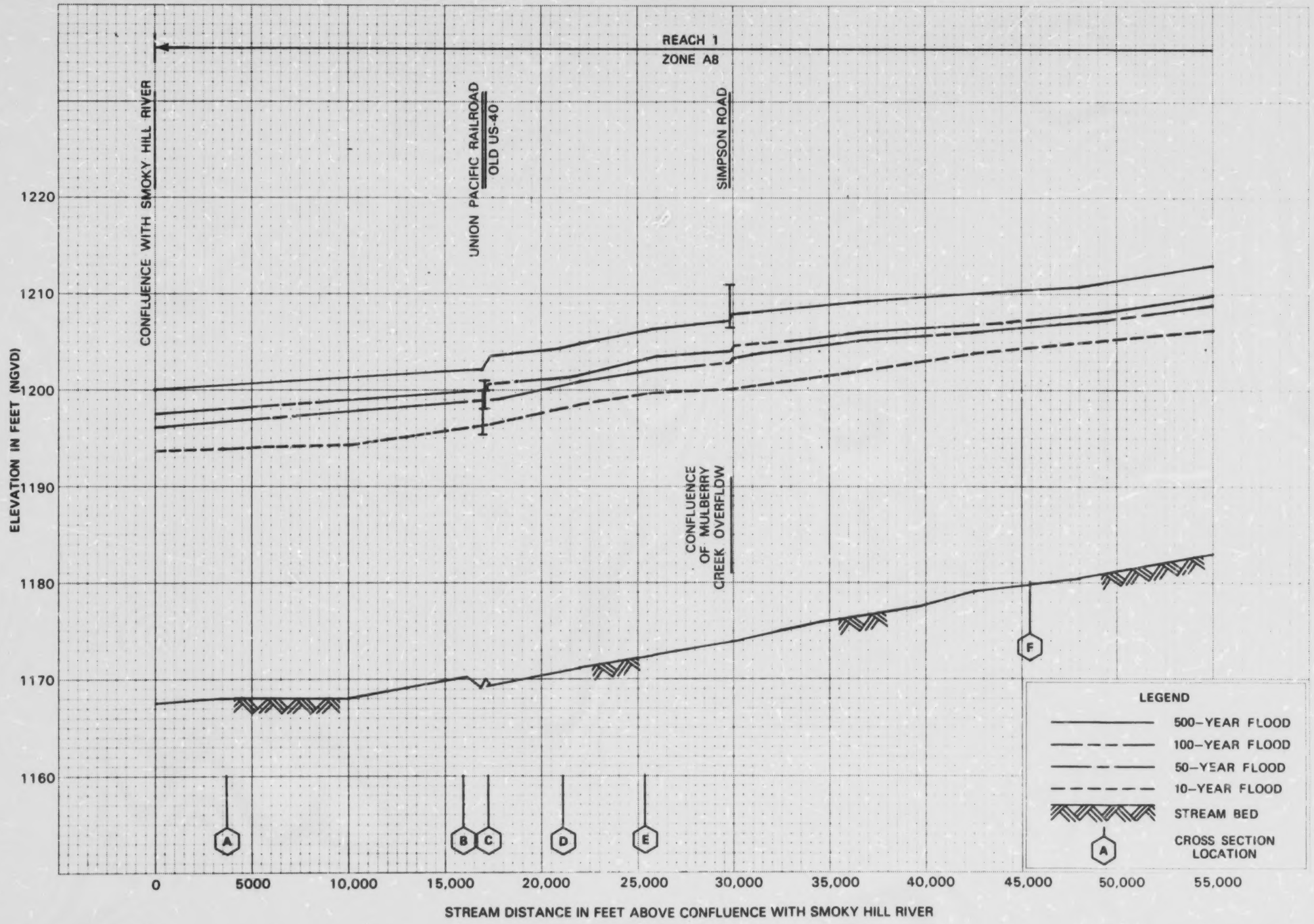


FLOOD PROFILES

SALINE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

SALINE COUNTY, KS
(UNINCORPORATED AREAS)

08P



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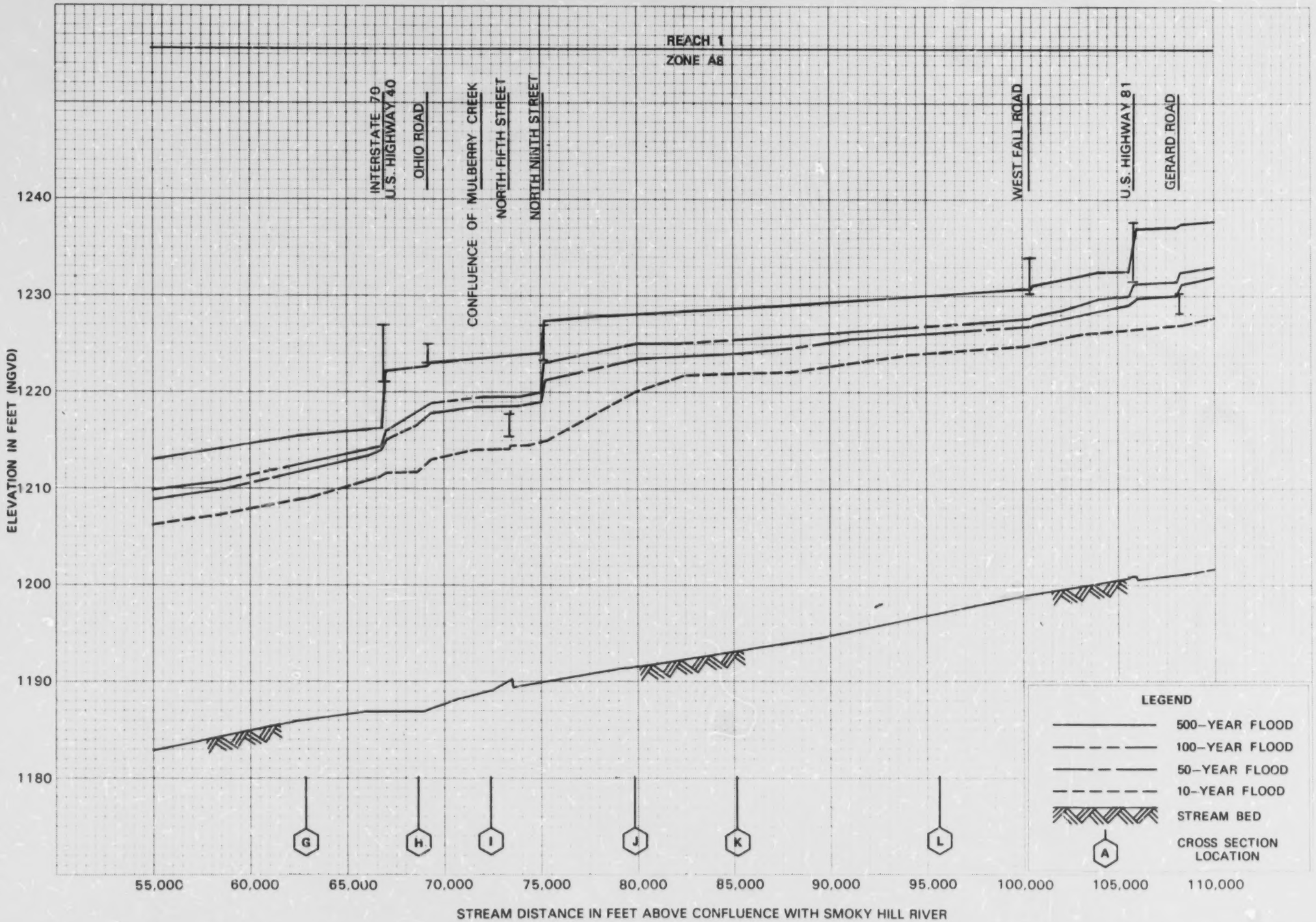


FLOOD PROFILES

SALINE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

SALINE COUNTY, KS
(UNINCORPORATED AREAS)

09P



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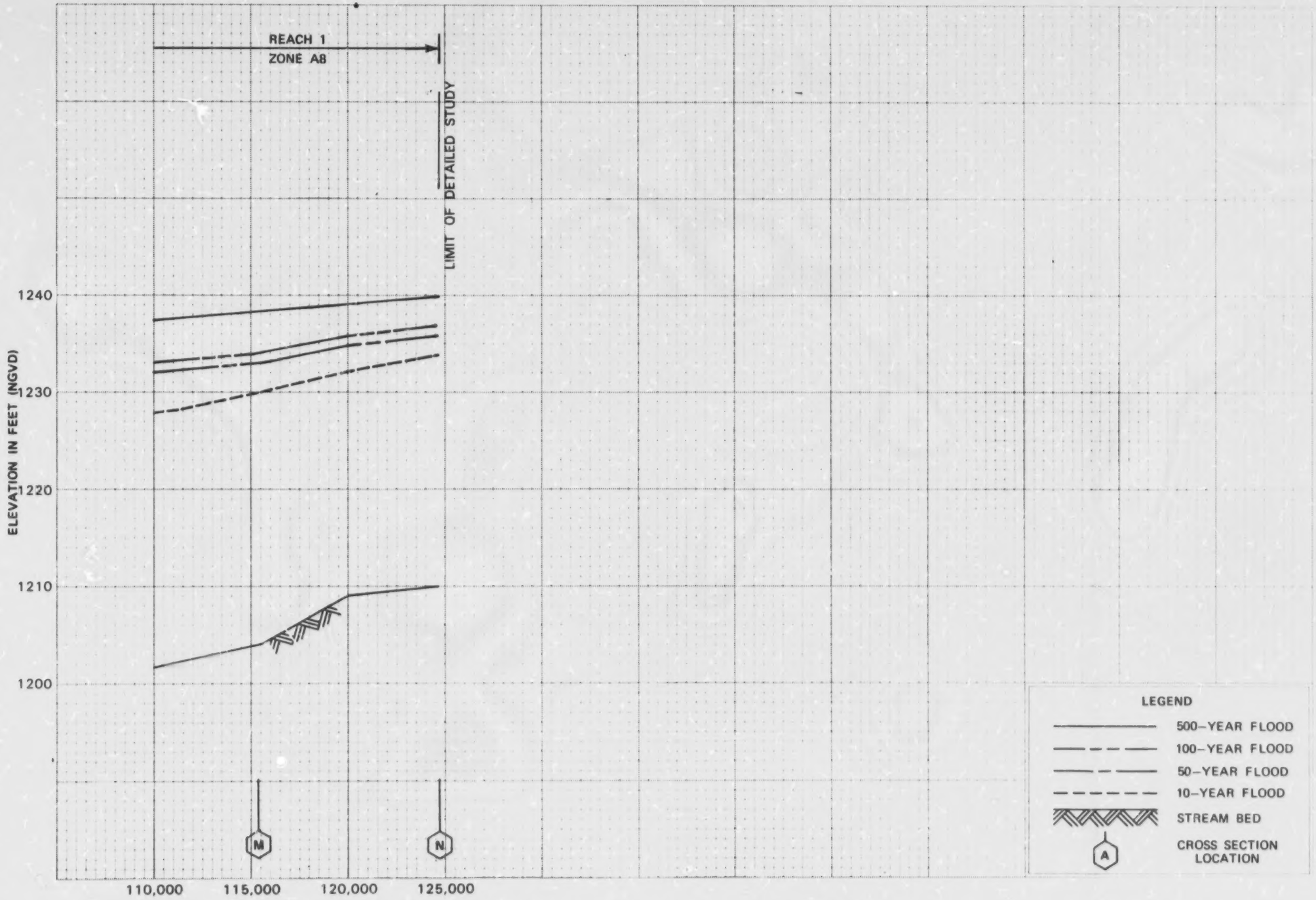


FLOOD PROFILES

SALINE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

SALINE COUNTY, KS
(UNINCORPORATED AREAS)

10P



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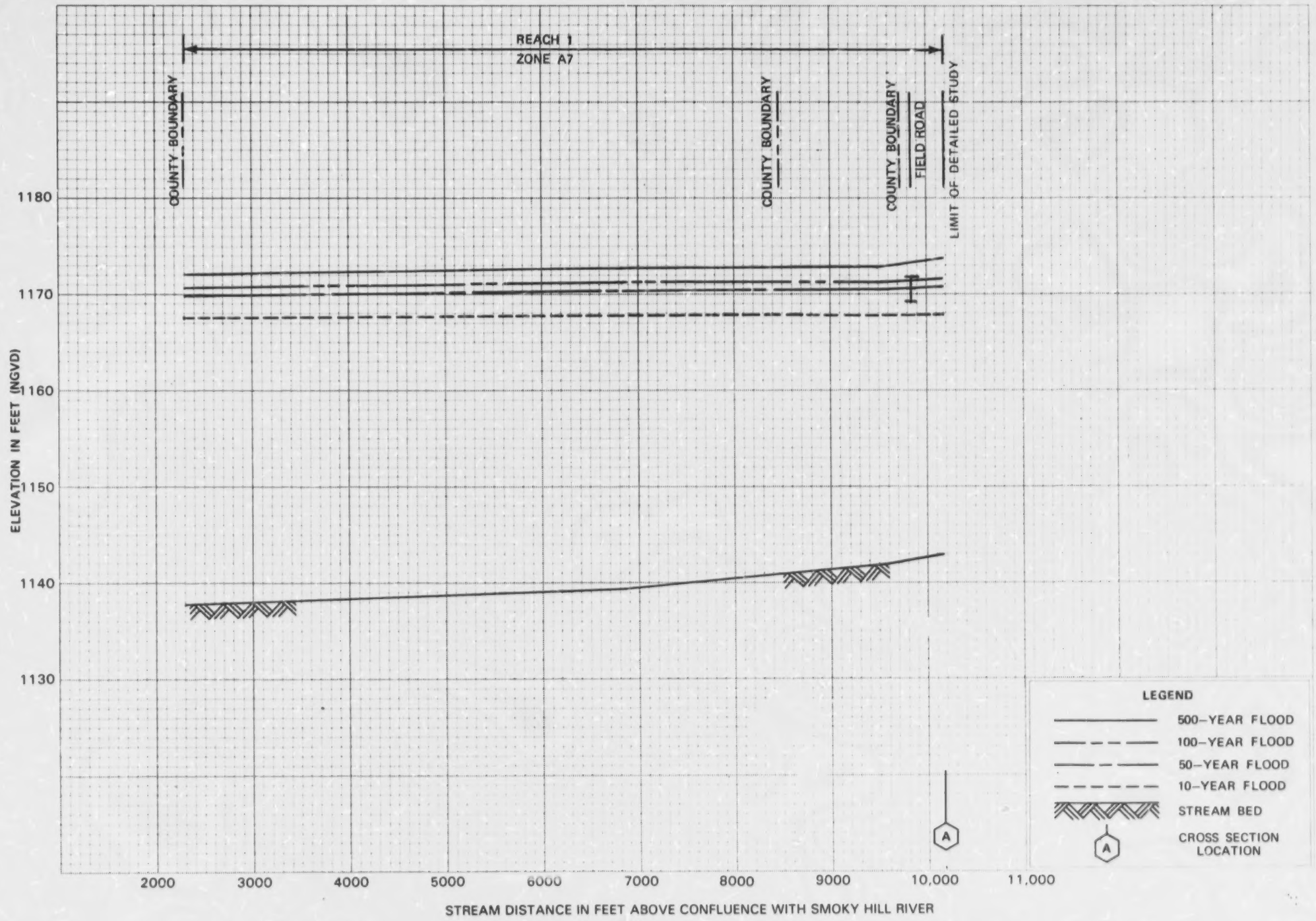


FLOOD PROFILES

SOLOMON RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

SALINE COUNTY, KS
(UNINCORPORATED AREAS)

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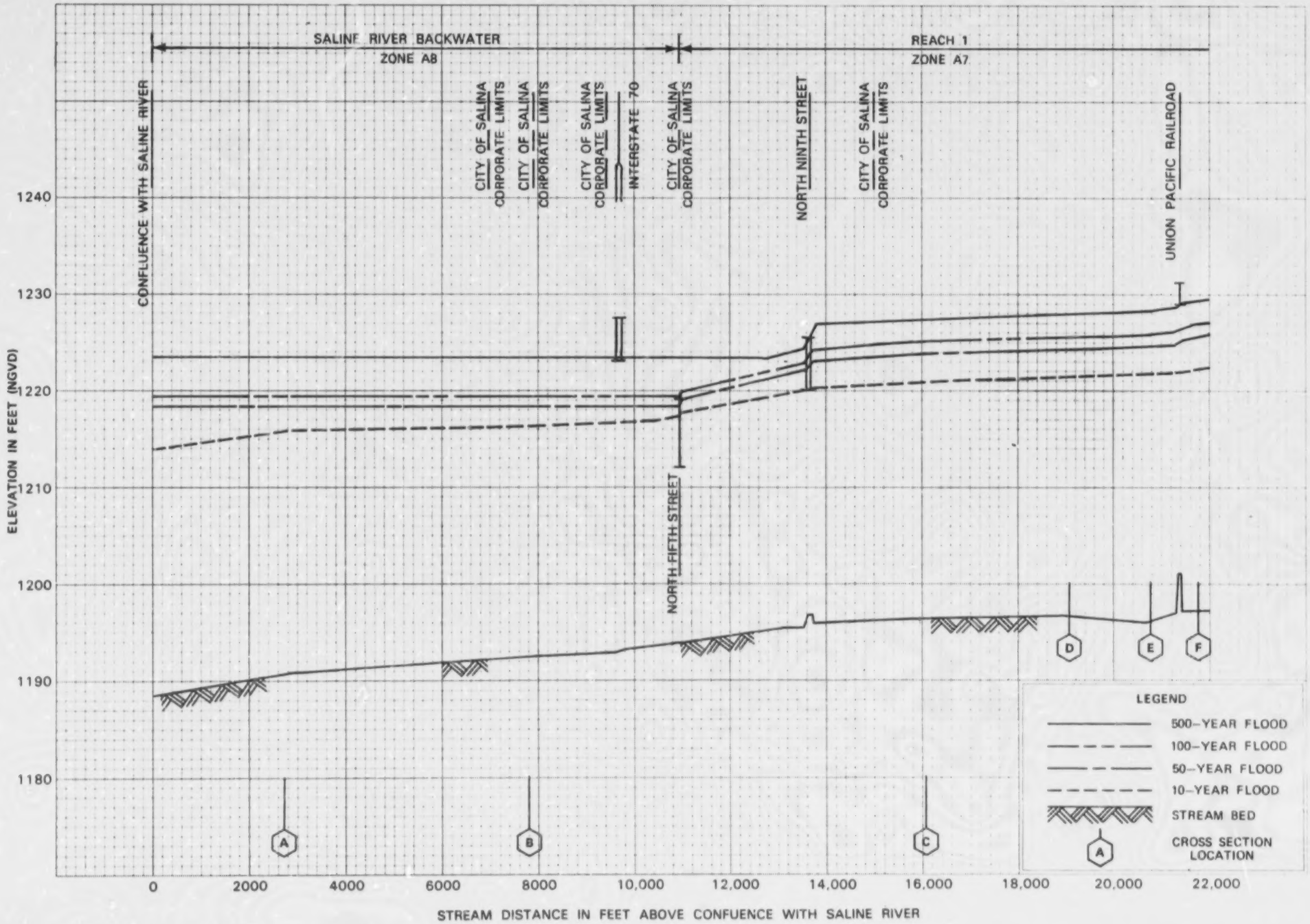


**FLOOD PROFILES**

**MULBERRY CREEK**

FEDERAL EMERGENCY MANAGEMENT AGENCY

**SALINE COUNTY, KS**

(UNINCORPORATED AREAS)

**12P**



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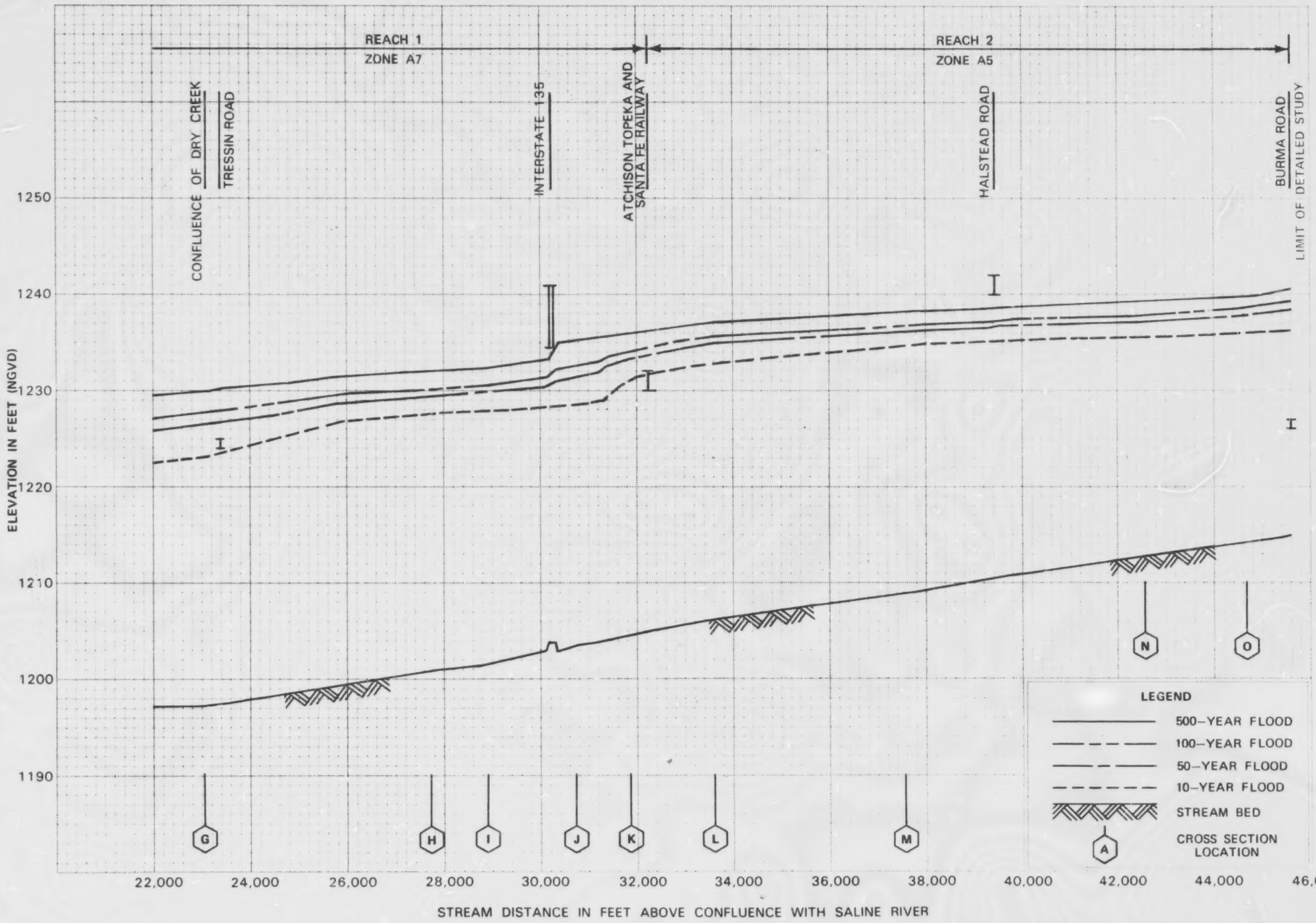


FLOOD PROFILES

MULBERRY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

SALINE COUNTY, KS
(UNINCORPORATED AREAS)

13P



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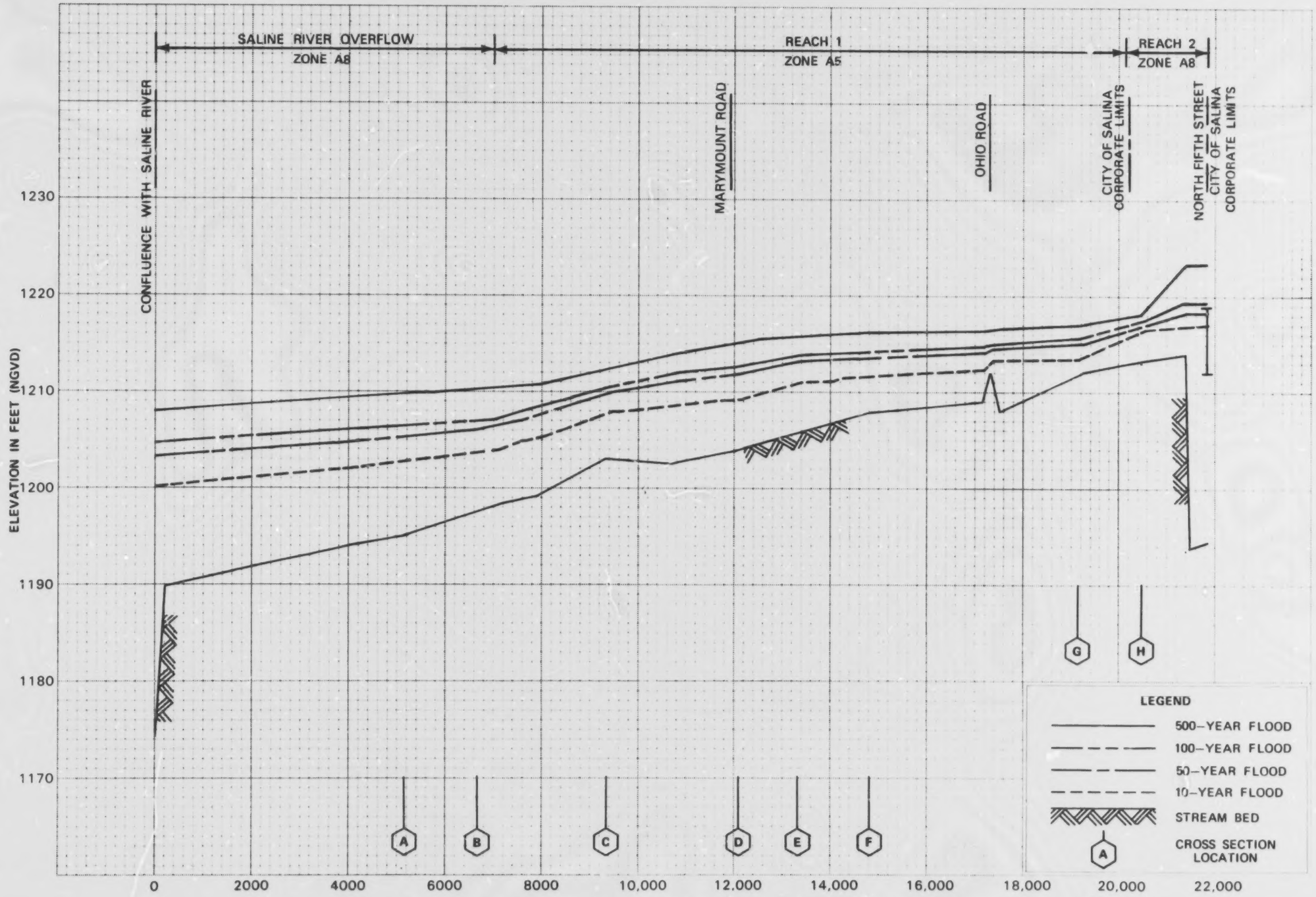


FLOOD PROFILES

MULBERRY CREEK OVERFLOW

FEDERAL EMERGENCY MANAGEMENT AGENCY

SALINE COUNTY, KS
(UNINCORPORATED AREAS)

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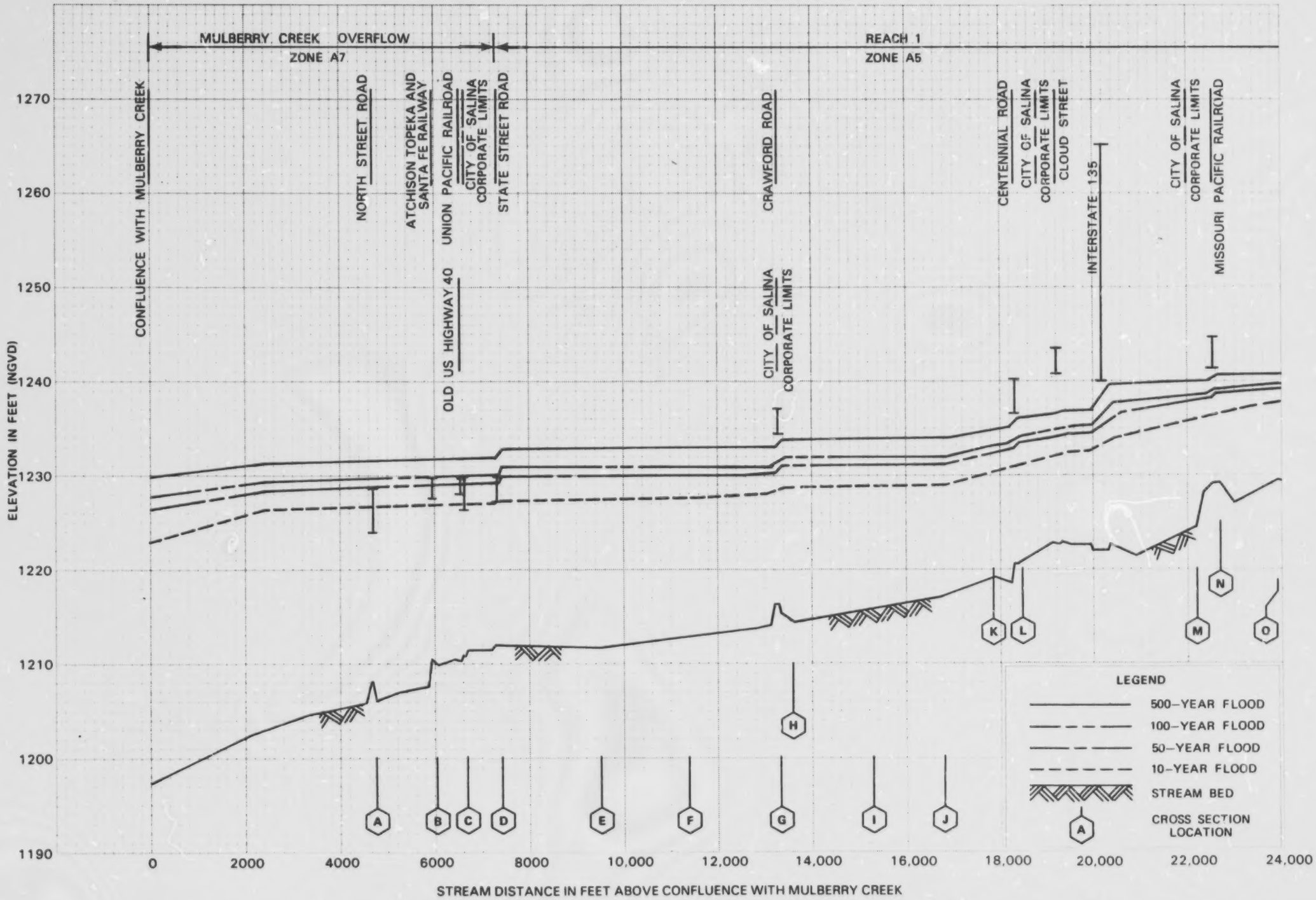


**FLOOD PROFILES**

**DRY CREEK**

FEDERAL EMERGENCY MANAGEMENT AGENCY

**SALINE COUNTY, KS**
(UNINCORPORATED AREAS)

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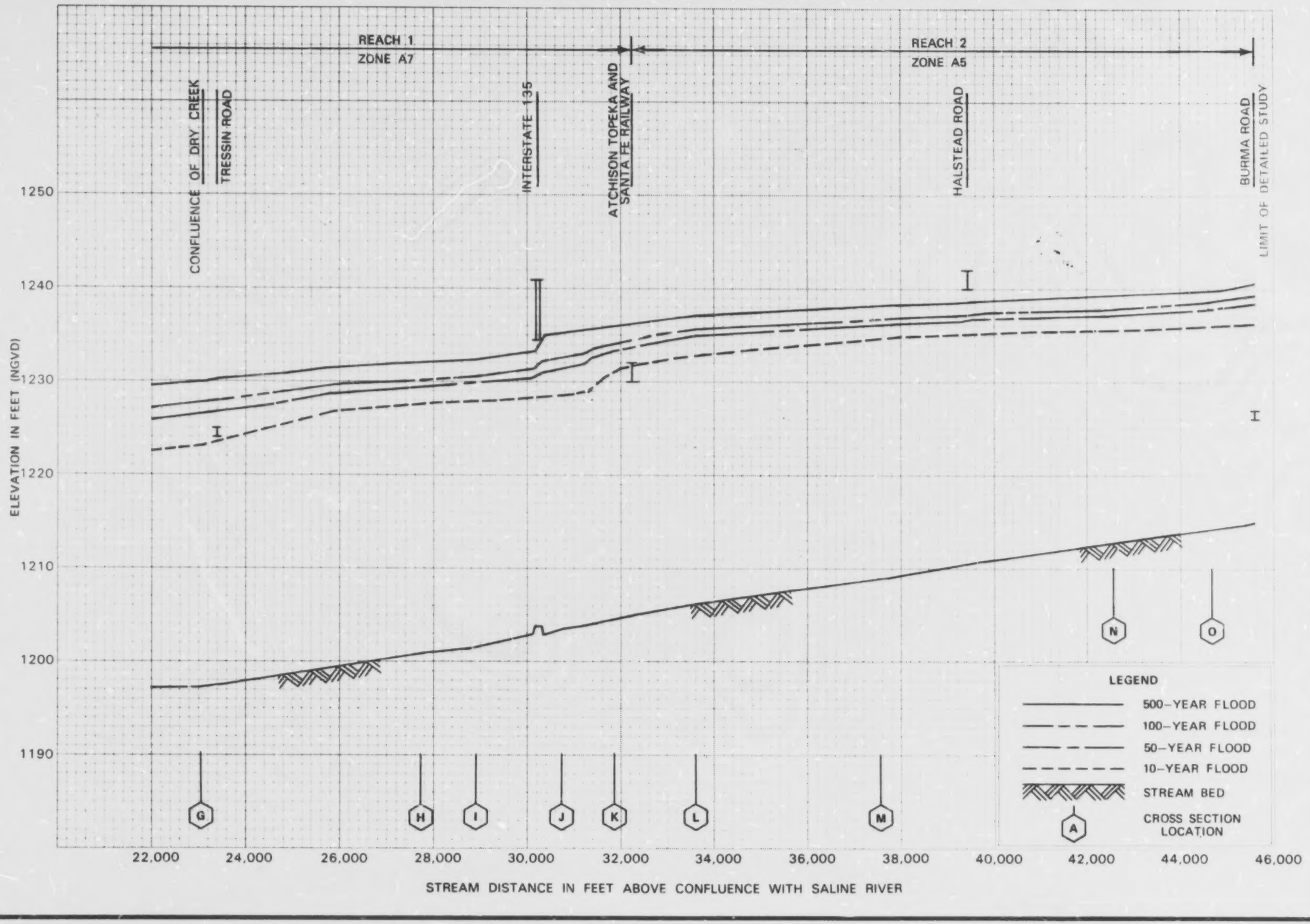


FLOOD PROFILES

MULBERRY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

SALINE COUNTY, KS
(UNINCORPORATED AREAS)

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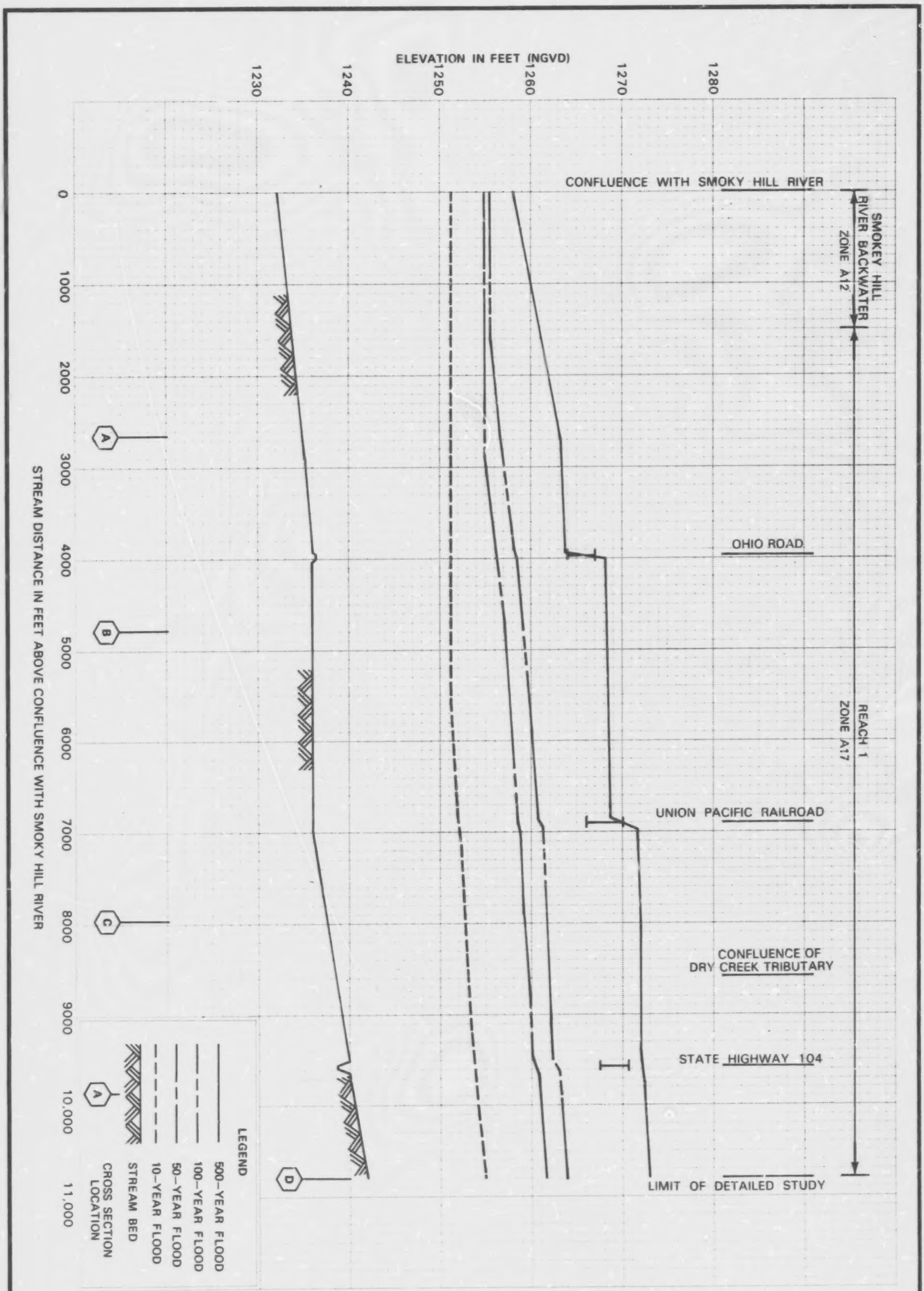


| 17P | FEDERAL EMERGENCY MANAGEMENT AGENCY<br>**SALINE COUNTY, KS**<br>(UNINCORPORATED AREAS) | **FLOOD PROFILES**<br>**DRY CREEK DIVERSION** |
|---|---|---|

59

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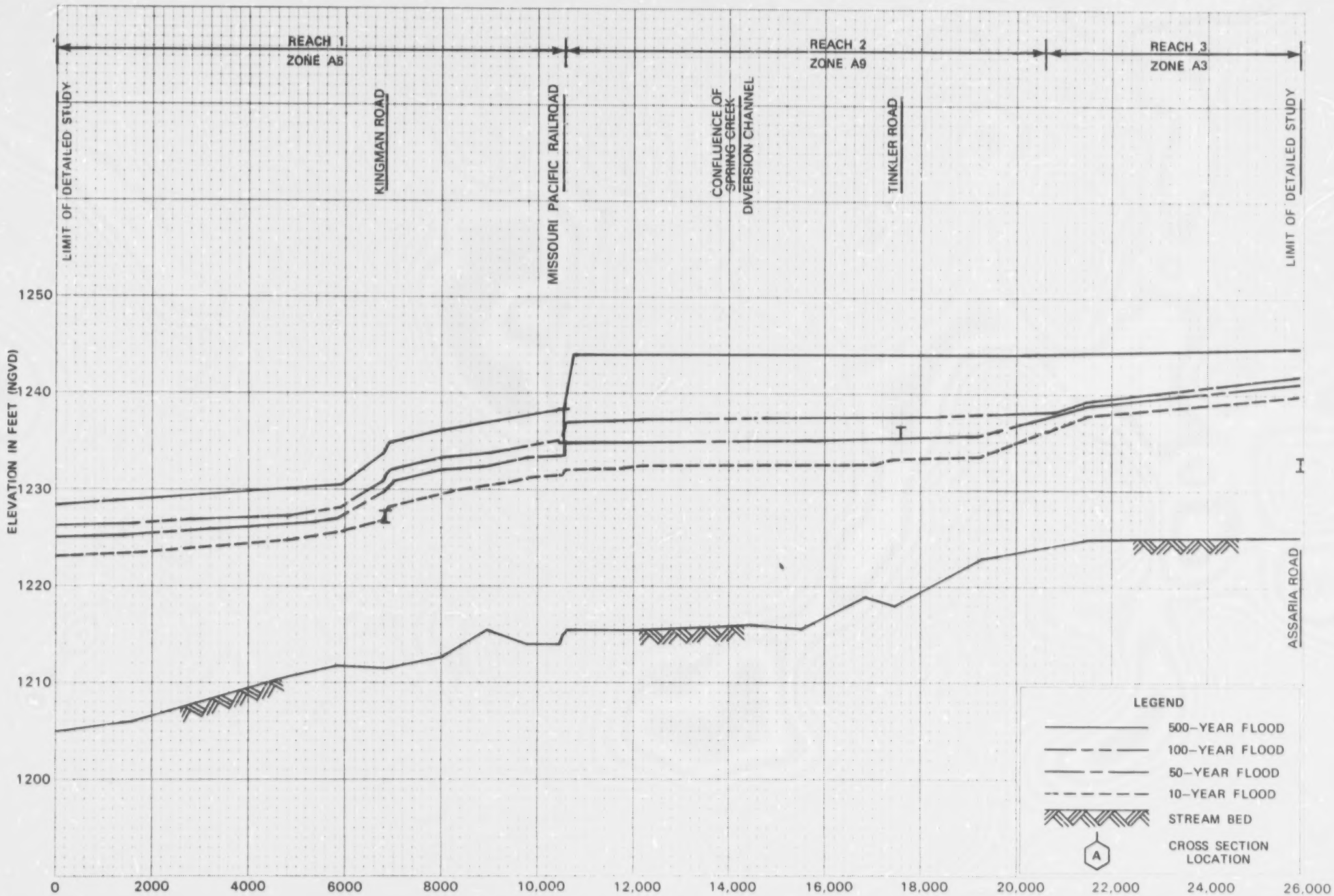


STREAM DISTANCE IN FEET ABOVE LIMIT OF DETAILED STUDY –
(LIMIT OF DETAILED STUDY IS 10,550 FEET DOWNSTREAM FROM MISSOURI PACIFIC RAILROAD)

FLOOD PROFILES

GYPSUM CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

SALINE COUNTY, KS
(UNINCORPORATED AREAS)

18P

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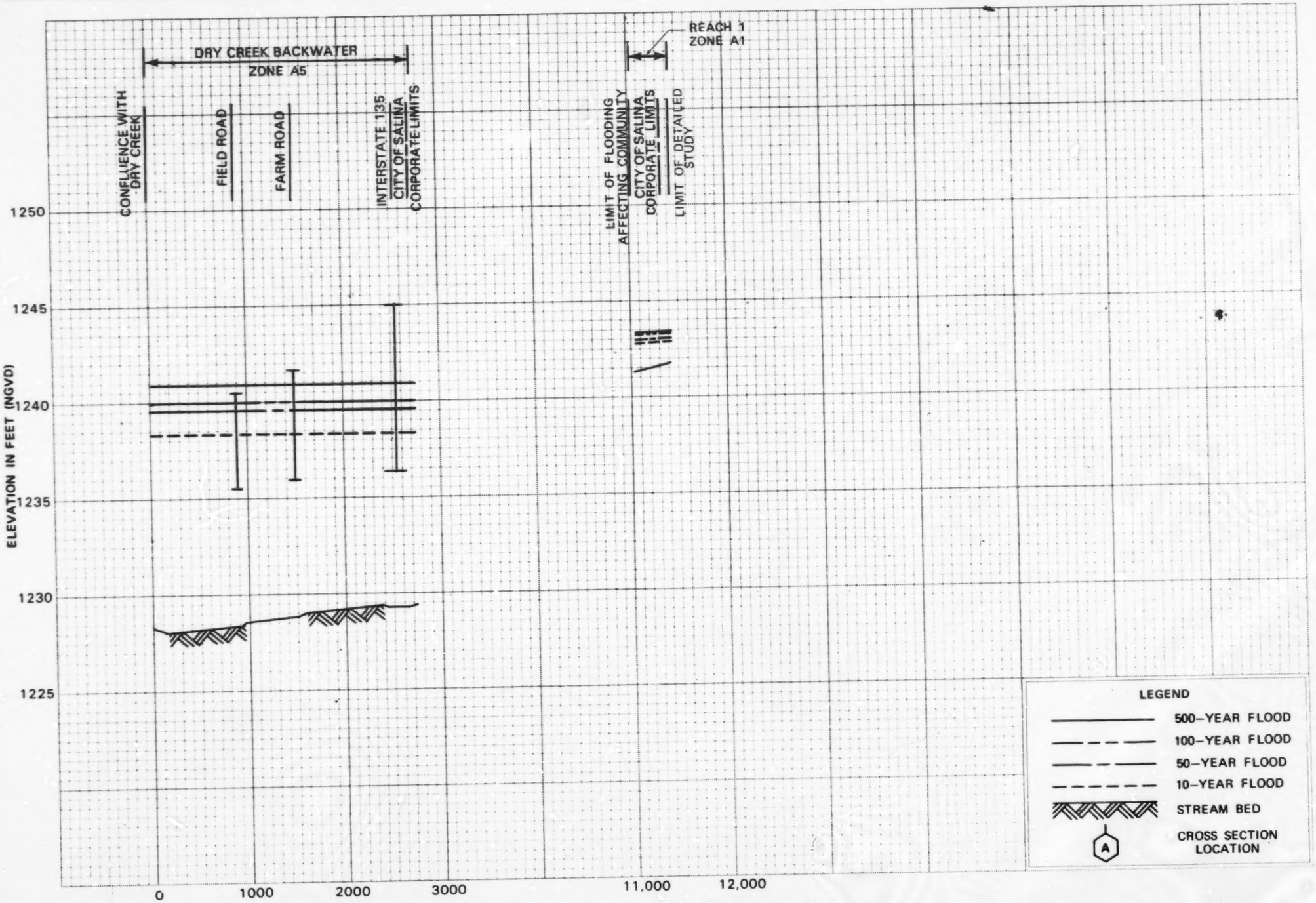


FLOOD PROFILES

MAGNOLIA ROAD DITCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

SALINE COUNTY, KS
(UNINCORPORATED AREAS)

19P

61

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